Popular Astronomy.

Vol. IX. No. 4. APRIL 1901. Whole No. 84.

ASTRONOMICAL BOOKS FOR THE USE OF STUDENTS.

HERBERT A. HOWE.

FOR POPULAR ASTRONOMY.

In this, the third article of our series, we shall mention general popular works, descriptive text-books and hand-books. No foreign descriptive text-books will be reviewed, because the writer has unfortunately not seen any which equal some of those published in this country.

In considering general popular works three well known popular writers have been omitted, R. A. Proctor, Miss Agnes Giberne and O. M. Mitchel. Their books are generally known, and it will be sufficient simply to recall the names of several of them. From Mr. Proctor's numerous writings of this character we select "Other Worlds than Ours," "Expanse of the Heavens," "Myths and Marvels of Astronomy," "Orbs around Us," and "Our place among Infinities;" these all have the uniform price of 3sh, 6d. Miss Giberne's charming style is in evidence in her "Sun, Moon Stars," "Among the Stars," and "Radiant Suns;" each of these sells for 5sh. General Mitchel's "Planetary and Stellar Worlds," though now quite out of date, well repays perusal, and is fairly entitled to be considered a classic because of the brilliancy of the author's exposition of his theme.

GENERAL POPULAR WORKS.

Ball: Starland; Ginn & Co., publishers; revised edition (1899); pp. 401; $1.00.

A course of lectures at the "Royal Institution of Great Britain," for a juvenile audience, furnished the ground-work for this delightful book. It is a masterpiece of astronomical writing for young people, and older heads are fascinated by it. Gladstone, in a letter to Sir Robert Ball, wrote "I have now finished reading your luminous and delightful Starland, and I am happy to be in a sense enrolled amongst your young pupils." Any one who wishes to address a popular audience on an astronomical theme will find a reading of this book beneficial.

Ball: The Story of the Heavens; Cassell & Co., publishers; pp. 556; $5.00.

This is generally regarded as the finest popular treatise on astronomy in our language. One who has had an elementary course in descriptive astronomy will read the book with delight and profit. The last chapter is a lucid presentation of Darwin's researches on Tidal Evolution. It is to be regretted that the last edition of this book is now ten years old.

Ball: In Starry Realms; J. B. Lippincott Co., importers; pp. 364; $2.50.

Here we find twenty-three finely written essays on such subjects as "What We Owe to the Sun," "A Visit to an Observatory," "Mars as a World," and "The Extent of the Sidereal Heavens." The last two chapters are non-astronomical, treating respectively of the famous eruption of Krakatoa, and of Darwinism.

Ball: In the High Heavens; J. B. Lippincott Co., publishers, pp. 383; $2.50.

Fifteen attractively written essays compose the book. Perhaps the most interesting topics are "The Physical Condition of Other Worlds," "The Wanderings of the North Pole," "The Fifth Satellite of Jupiter," "The Boundaries of Astronomy," "Is the Universe Infinite," and "Visitors from the Sky."

Clerk, Fowler and Gore: The Concise Knowledge of Astronomy; Hutchinson & Co., publishers; pp. 600; 5 sh.

To Miss Clerk were assigned the sections on the history of astronomy (only 36 pages), and the solar system. Her work was excellently done, considering the small number of pages into which she was obliged to compress the topics. Mr. Fowler wrote upon "Geometrical Astronomy" and "Astronomical Instruments;" his explanations are lucid and praiseworthy. The topic of "The Sidereal Heavens" fell to the lot of Mr. Gore, who is thoroughly conversant with his subject, and has collected a large amount of important information. The book is well printed and bound, and excellently illustrated. It belongs to a series in which "the maximum of excellence and the minimum of price" are sought.

Gore: Flammarion's Popular Astronomy; Chatto & Windus, publishers; pp. 679; 16 sh.

Mr. Gore has given an English translation of Flammarion's

work, which was so popular in France as to reach a sale of 100.000 copies. Flammarion's style of writing is familiar to every one. The book is graced by fine illustrations.

Gore: Geodesy; Houghton, Mifflin & Co., publishers; pp. 218; $1.25.

The author gives a short, reliable and interesting sketch of the chief attempts to measure the shape and size of the Earth, from the earliest times down to 1891.

Langley: The New Astronomy; Houghton, Mifflin & Co., publishers; pp. 260; $5.00.

This sumptuous and finely illustrated volume is the finest production of the pen of its gifted author, and gives a most delightful description of the secrets which have been wrested from the sky by the aid of the spectroscope, the sensitive plate, and other modern physical appliances. So rapid has been the development of astronomy in this direction that the volume is now necessarily behind the times in some respects.

Meyer: Das Weltgebäude; Bibliographisches Institut, publishers; 16 marks.

Dr. Meyer, as director of the celebrated Berlin "Urania," has had ample opportunity to develop his skill in popularizing science, and his success enhances the value of the work before us, which is a popular treatise on the heavens. The author first explains very fully the optical principles of the telescope, and describes some of the telescopic giants; then he explains photographic, photometric and spectroscopic processes. Thus the reader is enabled more intelligently to appreciate the results which have been obtained by the diligence of astronomers, and which are accurately and conservatively described in the remainder of the book. The subject of the measurement of the Earth is explained with a thoroughness and detail quite unequaled in other popular works on astronomy. The illustrations include 287 cuts, 10 charts, and 31 partly colored plates. They are, for the most part, beautiful and instructive. A few of them are terrestrial analogies of celestial appearances. Some highly colored ones are imagined views on other planets or their satellites. Dr. Meyer's luminous and instructive work steps easily into the front rank of similar treatises, and exhibits many points of divergence from them.

Newcomb: Popular Astronomy; Harper & Bros., publishers; pp. 578; $1.30.

This standard work has been before the public for about twenty years. It is very substantial, being packed with facts and reasonings. For one who does not wish the latest developments in astronomy, and relishes a straightforward, philosophic, open-minded discussion of the science, there is no better book in our language.

Schweiger-Lerchenfeld: Atlas der Himmelskunde auf Grundlage der Coelestischen Photographie; 62 Karten mit 187 Einzeldarstellungen und 67 Foliobogen Text mit 540 Abbildungen: 40 marks.

The opening chapter is on photography, and is illustrated with celestial photographs, portraits of astronomers and representations of notable instruments. Visual astronomy is then discussed in detail.* Instruments ancient and modern, observatories, the Sun, Moon, planets, etc., are briefly described and admirably pictured forth by an almost bewildering array of illustrations. Spectrum analysis is treated from its beginnings to its present magnificent development. The descriptive matter is brief, since the illustrations are the chief feature. Following the text come 62 plates, about half of which are reproductions of Weinek's lunar work. As a storehouse of astronomical pictures this work is unexcelled, and has well been called a "noble volume."

Todd: Stars and Telescopes; Little, Brown & Co., publishers; $2.00.

This is a hand-book of popular astronomy, based on the ninth edition of Lynn's "Celestial Motions," which is, however, so thoroughly reworked that the present volume is to be regarded as substantially a new work. It is written in Professor Todd's best style, and is therefore thoroughly readable. It is of special value to students and teachers because each chapter has an appendix containing information upon the topic in hand. Illustrations abound; several of them are portraits of eminent astronomers.

Descriptive Text-Books.

Newcomb: Elements of Astronomy; American Book Co., publishers; pp. 240.

This neat little book is intended as a text for use in high schools, or even in colleges, when only a very short and simple treatment of the subject is desired. Professor Newcomb, as was to be expected, treats some topics in quite original ways, and

does not hesitate to express very conservative opinions on such points as the canals and atmosphere of Mars. The book is of interest as showing how admirably one of the greatest of mathematical astronomers adapts himself to the needs of beginners, and how he views the claims of modern observers concerning mooted points.

Holden: Elementary Astronomy; Henry Holt & Co., publishers; pp. 446.

Professor Holden in conjunction with Professor Newcomb prepared a text-book some twenty years ago; afterwards Professor Holden abridged it. The present work is based on the two preceding ones, and is of the same general character. But the details have been largely altered, and many new and helpful pictures have been inserted. The feature in which the book differs from most elementary astronomies is the very full treatment of the rudimentary mathematics of the subject. No fewer than 268 pages are thus used. To the simple topic of the diurnal motion 38 pages are devoted. The description of the solar system is compressed into 80 pages. The concluding chapter is on "Practical Hints for Observing," and is followed by lists of the chief objects of interest in the sky. A few small maps and a seven page appendix on spectrum analysis, together with the index, complete the volume.

Young: A Text-book of General Astronomy; Ginn & Co., publishers; pp. 630; $2.75.

The last edition of this standard work was issued in 1898, and contains a good deal of matter not to be found in the earlier issues. Seventy-nine pages have been added. At the close of every chapter is now to be found a short set of exercises. Supplementary articles, to bring the discussions down to date, abound. One entirely new appendix of 19 pages contains chiefly matters of interest about the computation of orbits and of lunar eclipses. It is well known that this book of Professor Young's stands alone, as the best semi-mathematical descriptive astronomy extant.

Young: Elements of Astronomy; Ginn & Co., publishers; pp. 506; $1.60

This text-book is so familiar to the readers of POPULAR ASTRONOMY; that a description of it is quite unnecessary. The edition of 1897 contains a dozen new pages entitled "Synopsis for Review and Examination."

Young: Lessons in Astronomy; Ginn & Co., publishers; pp. 366; $1.20.

Professor Young has here simplified his "Elements" in order to produce a book which shall more nearly meet the demands of the average college-fitting school.

Todd: A New Astronomy; American Book Co., publishers; pp. 480.

The most striking thing about this book is the wealth and originality of the illustrations. No other text-book known to the writer equals it in this particular. The information given is brought thoroughly down to date, and evinces the wide reading of the author. No matter what text may be in a student's hands he will find much that is novel in this book. One feature is the treatment of the planets, which are not discussed individually, as usual. For example the satellites of the different planets are treated consecutively, then the atmospheres of the planets, then their surfaces, etc. Professor Todd states that he has "aimed to present astronomy, not as a sequence of isolated and imperfectly connected facts, but as an inter-related series of philosophic principles."

Byrd: A Laboratory Manual in Astronomy; Ginn & Co., publishers; pp. 273.

Miss Byrd's object is to supplement ordinary courses in descriptive astronomy by exercises which compel research on the part of students. The exercises for the most part demand observation of the heavens either with the naked eye, or with home-made instruments. But many of them are of the nature of inquiries to be answered from a study of books, maps and apparatus. The two opening chapters give admirable general directions for making and recording observations, and for the construction of home-made apparatus. The next two are devoted to the use of almanacs, maps, the globe, and the heliotellus. The remaining chapters treat of observations of the heavenly bodies. This book has a peculiar value, because it is the result of fifteen years of actual experimentation with college students.

HAND-BOOKS.

Chambers: Hand-book of Descriptive and Practical Astronomy; Fourth Edition; The Clarendon Press, publishers; 3 vols.; pp. 1618; $14.00.

This great work is intended to be "at one and the same time attractive to the general reader, serviceable to the student, and

handy for purposes of reference to the professional astronomer." It is, without doubt, the best thesaurus of information on astronomical subjects, in our language. The fourth edition was published about ten years ago. The three volumes are sold separately, if desired. The first, which contains 676 pages, is devoted to the solar system. Especial features of the treatment of comets are a chapter on a graphical method of computing their orbits; and two other chapters containing descriptive lists of all known comets.

The second volume contains 558 pages, and treats of "Instruments and Practical Astronomy." It is therefore specially adapted to the needs of amateur astronomers, and is a veritable vade-mecum for them. Telescopes of all sorts, domes, small observatories, and accessory apparatus of various kinds are described and pictured.

The third volume occupies itself with "The Starry Heavens," and contains 384 pages. About one-third of the space is devoted to general matter about double stars, variables, clusters, nebulæ, and the Milky Way. The next third of the book is arranged by constellations; for each star group are given the names, right ascensions, declinations, and magnitudes of its principal stars. Then follow lists of nebulæ and clusters, of variables, of red stars and of suspected binaries.

Wolf: Handbuch der Astronomie; 2 vols.; F. Schulthess, publisher; pp. 1370.

This work is the crowning one of the author's writings, and contains a large amount of material which he collected with great diligence. The work is divided into four books. The first book contains 384 pages; fifty of these are devoted to a very condensed sketch of the history of the science. In the remainder of the book are given preliminary notions drawn from analysis, geometry, mechanics and physics. These preliminary matters are sufficiently advanced to engage the careful attention of a college student.

The second book embraces over 300 pages, and is entitled "Introduction to Astronomy." It contains, in the main, material similar to that given in works on Descriptive Astronomy, such as Young's General Astronomy. There is also a mass of historical notes scattered throughout the text; such notes, we may here say, are to be found throughout the entire work.

The third book handles the theory of instruments and of the measurements made with them. One finds, however, no refer-

ence to the spectroscope. About 75 pages are devoted to geodetic measures. An equal amount of space is occupied by parallax, refraction, eclipses and occultations.

The fourth book discusses the mechanics and physics of the heavens in a semi-mathematical fashion. The titles of the sections are The Law of Gravitation, The Sun, The Planets, Shooting Stars and Comets, Stellar Astronomy, Star Systems. In this portion of the work the author makes the barest mention of photography, photometry and spectroscopy.

On the whole, Dr. Wolf's work may be characterized as a repository of an immense number of details concerning the history and literature of astronomy, mingled with mathematical explanations of the important problems of the Old Astronomy. Fortunately there is quite an exhaustive index.

Proctor and Ranyard: Old and New Astronomy; Longmans, Green & Co., publishers; pp. 824; $12.00.

Mr. Proctor, whose numerous writings have done so much toward popularizing astronomy, considered this work as the crown of his astronomical endeavors. He was unable to bring it to completion, on account of his death, and Mr. Ranyard, then editor of *Knowledge*, supplied the portion which was lacking, and edited the whole. Unfortunately Mr. Proctor had written nothing about the stars, the distribution of nebulæ, and the construction of the Milky Way, though these were favorite topics on which he had speculated with much acuteness. Mr. Ranyard has given the most prominent theories on these subjects. The book is in quarto, and is adorned by 500 illustrations.

ANCIENT ECLIPSES AND CHRONOLOGY.

R. W. McFARLAND.

For Popular Astronomy.

In December, 1899, there was printed in this journal a paper which had been read before the Astronomical Section of the American Association for the Advancement of Science, at its meeting in Columbus, Ohio, in the preceding summer. The subject under discussion was whether ancient eclipses have been the means of establishing the dates of historical events. And inasmuch as the eclipse of Thales was by far the most noted in history, a special examination was made in regard to that eclipse. The conclusion was given as follows: "Here we have ancients and

moderns, historians and mathematicians,—English, German, French—asserting in words as positive as the English language affords, that this eclipse took place at nine different dates, scattered over forty-six years of time; while the two men most competent to form an opinion, differ by nearly twenty-five years."

In subsequent examination of the same subject, I fell on three other dates widely separated in years, so that the dates of that eclipse number twelve, scattered over eighty-six years of time. To say that any date of history is fixed by the eclipse of Thales, is to speak nonsense.

In continuation of the general discussion, I took all the solar eclipses given in the London Cyclopedia, and also a few not given in that table but found elsewhere. The results of the examination were singularly uniform—so much so that I deem it unnecessary to give the particulars in any case. For in every case, without a single exception, wherein the date of the eclipse is given by different authors, *there are as many different dates as there are authors*; two authors, two different dates; three authors, three different dates, etc.

I repeat here the criticism of Sir John Herschel: "Whenever any such eclipse is so interwoven with the account given by an ancient authority, of some historical event, as to indicate precisely the interval of time between the eclipse and the event, and at the same time completely to identify the eclipse, that date is recovered and fixed forever."

Let it suffice to say that no such agreement is found in a single case. The eclipses here spoken of all occurred before the reformation of the calendar by Julius Cæsar. But subsequent to that event I find the death of Augustus, the successor of Julius, referred to three different years, all depending on the date of an eclipse. The difficulty is not at all the fault of the astronomer. It lies with the historian, in that he has not written in such a way as to conform to Herschel's criticism. "How far then has the record of eclipses aided men in their chronology?" Logic allows but one answer, and the way-faring man can give it as correctly as the sage or the philosopher.

THE ASTRONOMER'S POLE.

HAROLD JACOBY.

The pole of the frozen North is not the only pole sought with determined effort by more than one generation of scientific men.

Up in the sky astronomers have another pole which they are following up just as vigorously as ever Arctic explorer struggled toward the difficult goal of his terrestrial journeying. The celestial pole is indeed a fundamentally important thing in astronomical science, and the determination of its exact position upon the sky has always engaged the closest attention of astronomers. Quite recently new methods of research have been brought to bear, promising a degree of success not hitherto attained in the astronomers' pursuit of their pole.

In the first place, we must explain briefly what is meant by the celestial pole. Every one knows the poles of the Earth. Our planet turnes once daily upon an axis passing through its center, and it is this rotation that causes all the so-called diurnal phenomena of the heavens. Rising and setting of Sun, Moon and stars are simply results of this turning of the Earth. Heavenly bodies do not really rise; it is merely the man on the Earth who is turned round on an axis until he is brought into a position where he can see them. The terrestrial poles are those two points on the Earth's surface where it is pierced by the rotation axis of the planet. Now we can, if we choose, imagine this axis lengthened out indefinitely, further and further, until at last it reaches the great round vault of the sky. Here it will again pierce out two polar points; and these are the celestial poles. The whole thing is thus quite easy to understand. On the sky the poles are marked by the prolongation of the Earth's axis, just as on the Earth the poles are marked by the axis itself. And this explains at once why the stars seem nightly to revolve about the pole. If the observer is being turned round the Earth's axis, of course it will appear to him as if the stars were rotating around the same axis in the opposite direction, just as houses and fields seem to fly past a person sitting in a railway train, unless he stops to remember that it is really himself who is in motion, and not the trees and houses.

The existence of such a center of daily motions among the stars once recognized, it becomes of interest to ascertain whether that center itself always retains precisely the same position in the sky. It was discovered as early as the time of Hipparchus (120 B. C.) that such is not the case, and that the celestial pole is subject to a slow motion among the stars on the sky. If a given star were today situated exactly at the pole it would no longer be there after the lapse of a year's time; for the pole would have moved away from it. This motion of the pole is called precession. It means that certain forces are continually

at work, compelling the Earth's axis to change its position, so that the prolongation of that axis must pierce the sky at a point which moves as time goes on. These forces are produced by the gravitational attractions of the Sun, Moon and planets upon the matter composing our Earth. If the Earth were perfectly spherical in shape the attractions of the other heavenly bodies would not affect the direction of the Earth's rotation axis in the least. But the Earth is not quite globular in form; it is flattened a little at the poles and bulges out somewhat at the equator. This protuberant matter near the equator gives the other bodies in the solar system an opportunity to disturb the Earth's rotation. The general effect of all these attractions is to make the celestial pole move upon the sky in a circle having a radius of about 23½ degrees; and it requires 25,800 years to complete a circuit of this precessional circle. One of the most striking consequences of this motion will be the change of the polar star. Just at present the bright star Polaris in the constellation of the Little Bear is very close to the pole. But after the lapse of sufficient ages the first magnitude star Vega of the constellation Lyra will in its turn become Guardian of the Pole.

It must not be supposed, however, that the motion of the pole proceeds quite uniformly, and in an exact circle; the varying positions of the heavenly bodies whose attractions cause the phenomena in question are such as to produce appreciable divergencies from exact circular motion. Sometimes the pole deviates a little to one side of the precessional circle, and sometimes it deviates on the other side. The final result is a sort of wavy line, half on one side and half on the other of an average circular curve. It takes only nineteen years to complete one of these little waves of polar motion, so that in the whole precessional cycle of 25,800 years, there are about 1,400 indentations. This disturbance of the polar motion is called by astronomers Nutation.

The first step in a study of polar motion is to devise a method of finding just where the pole is on any given date. If the astronomer can ascertain by observational processes just where the pole is among the stars at any moment, and can repeat his observations year after year and generation after generation, he will possess in time a complete chart of a small portion at least of the celestial pole's vast orbit. From this he can obtain necessary data for a study of the mathematical theory of attractions, and thus perhaps arrive at an explanation of the fundamental laws governing the universe in which we live.

The only instrument which has been used extensively for the study of these problems is the so-called "meridian circle." This consists of a telescope very firmly attached to a heavy metallic axis about which it can turn. The axis itself rests on massive stone supports, and is so placed that it points as nearly as possible in an east-and-west direction. Consequently, when the telescope is turned about its axis, it will trace out on the sky a great circle (the meridian) which passes through the north and south points of the horizon and the point directly overhead. The instrument has also a metallic circle very firmly fastened to the telescope and its axis. Let into the surface of this circle is a silver disk upon which are engraved a series of lines or graduations by means of which it is possible to measure angles.

Observers with the meridian circle can determine the exact instant when any given star passes the center of the field of view of the telescope. This center is marked with a cross made by fastening into the focus two pieces of ordinary spider's web, which give a well-marked, delicate pair of lines, even under the magnifying power of the telescope's eye-piece. In addition to thus noting the time when the star crosses the field of the telescope, the astronomer can measure by means of the circle, how high up it was in the sky at the instant when it was thus observed.

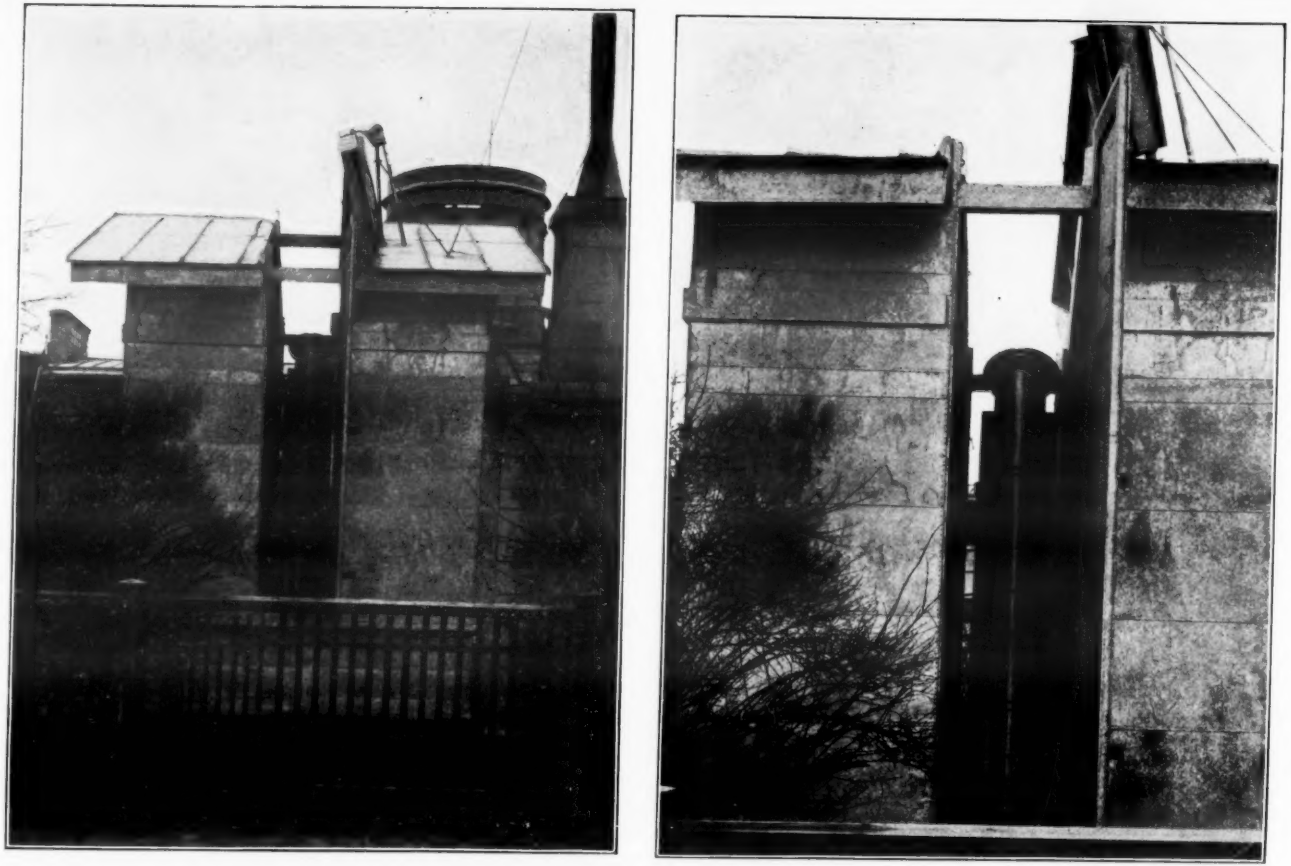
If the telescope of the meridian circle be turned towards the north, and we observe stars close to the pole, it is possible to make two different observations of the same star. For the close polar stars revolve in such small circles around the pole of the heavens that we can observe them when they are upon the meridian either above the pole or below it. Double observations of this class enable us to obtain the elevation of the pole above the horizon, and to fix its position with respect to the stars.

Now, there is one very serious objection to this method. In order to secure the two necessary observations of the same star, it is essential to be stationed at the instrument at two moments of time separated by exactly twelve hours; and if one of the observations occurs in the night, the other corresponding observation will occur in daylight. It is a fact not generally known that the brighter stars can be seen with a telescope, even when the Sun is quite high above the horizon. Unfortunately, however, there is only one star close to the pole which is bright enough to be thus observed in daylight—the Polar star already mentioned under the name Polaris. The fact that we are thus limited to observations of a single star has made it difficult even for genera-

PLATE V.

THE OBSERVATORY OF HELSINGFORS IN FINLAND.

PLATE VI.



THE FIXED PHOTOGRAPHIC TELESCOPE OF THE HELSINGFORS OBSERVATORY.

tions of astronomers to accumulate with the meridian circle a very large quantity of observational material suitable for the solution of our problem.

The new method of observation to which we have referred above consists in an application of photography to the polar problem. If we aim at the pole a powerful photographic telescope, and expose a photographic plate throughout the entire night, we shall find that all stars coming within the range of the plate will mark out little circles or "trails" upon the developed negative. It is evident that as the stars revolve about the pole on the sky, tracing out their daily circular orbits, these same little circles must be reproduced faithfully upon the photographic plate. The only condition is that the stars shall be bright enough to make their light affect the sensitive gelatine surface.

But even if observations of this kind are continued throughout all the hours of darkness, we do not obtain complete circles, but only those portions of circles traced out on the sky between sunset and sunrise. If the night is twelve hours in length, we get half-circles on the plate; if it is eighteen hours long, we get circles that lack only one-quarter of being complete. In other words, we get a series of circular arcs, one corresponding to each close polar star. There are no less than sixteen stars near enough to the pole to come within the range of a photographic plate, and bright enough to cause measurable impressions upon the sensitive surface. The fact that the circular arcs are not complete circles does not in the least prevent our using them for ascertaining the position of their common center; and that center is the pole. Moreover, as the arcs are distributed at all sorts of distances from the pole and in all directions, corresponding to the accidental positions of the stars on the sky, we have a state of affairs extremely favorable to the accurate determination of the pole's place among the stars by means of microscopic measurements of the plate.

It will be perceived that this method is extremely simple, and therefore likely to be successful; though its simplicity is slightly impaired by the phenomenon known to astronomers as "atmospheric refraction." The rays of light coming down to our telescopes from a distant star must pass through the Earth's atmosphere before they reach us; and in passing thus from the nothingness of outer space into the denser material of the air, they are bent out of their straight course. The phenomenon is analogous to what we see when we push a stick down through the surface of still water; we notice that the stick appears to be bent

THE FIXED PHOTOGRAPHIC TELESCOPE OF THE HELSINGFORS OBSERVATORY.
POPULAR ASTRONOMY No. 84.

at the point where it pierces the surface of the water, and in just the same way the rays of light are bent when they pierce into the air. Fortunately, the mathematical theory of this atmospheric bending of light is well understood, so that it is possible to remove the effects of refraction from our results by a process of calculation. In other words, we can transform our photographic measures into what they would have been if no such thing as atmospheric refraction existed. This having been done, all the arcs on the plate should be exactly circular, and their common center should be the position of the pole among the stars on the night when the photograph was made.

It is possible to facilitate the removal of refraction effects very much by placing our photographic telescope at some point on the Earth situated in a very high latitude. The elevation of the pole above the horizon is greatest in high latitudes. Indeed, if Arctic voyagers could ever reach the pole of the Earth they would see the pole of the heavens directly overhead. Now, the higher up the pole is in the sky, the less will be the effects of atmospheric refraction; for the rays of light will then strike the atmosphere in a direction nearly perpendicular to its surface, which is favorable to diminishing the amount of bending. There is also another very important advantage in placing the telescope in a high latitude; in the middle of winter the nights are very long there; if we could get within the Arctic Circle itself, there would be nights when the hours of darkness would number twenty-four, and we could substitute complete circles for our broken arcs. This would, indeed, be most favorable from the astronomical point of view; but the essential condition of convenience for the observer renders an expedition to the frozen Arctic regions unadvisable.

But it is at least possible to place the telescope as far north as is consistent with retaining it within the sphere of civilized influences. We can put it in that one of existing observatories on the Earth which has the highest latitude; and this is the Observatory of Helsingfors in Finland, which belongs to a great university, is manned by competent astronomers, and has a latitude greater than 60 degrees.

Dr. Anders Donner, Director of the Helsingfors Observatory, has at his disposal a fine photographic telescope, and with this some preliminary experimental "trail" photographs were made in 1895. These photographs were sent to Columbia University, New York, and were there measured under the writer's direction. Calculations based on these measures indicate that the method

is promising in a very high degree; and it was therefore decided to construct a special photographic telescope better adapted to the particular needs of the problem in hand. The desirability of a new telescope arises from the fact that we wish the instrument to remain absolutely unmoved during all the successive hours of the photographic exposure. It is clear that if the telescope moves while the stars are tracing out their little trails on the plate, the circularity of the curves will be disturbed. Now, ordinary astronomical telescopes are always mounted upon very stable foundations, well adapted to making the telescope stand still; but the polar telescope which we wish to use in a research fundamental to the entire science of astronomy, ought to possess immobility and stability of an order higher than that required for ordinary astronomical purposes.

It is a remarkable peculiarity of the instrument needed for the new trail photographs that it is never moved at all. Once pointed at the pole, it is ready for all the observations of successive generations of astronomers. It should have no machinery, no pivots, axes, circles, clocks or other paraphernalia of the usual equatorial telescope. All we want is a very heavy stone pier, with a telescope tube firmly fastened to it throughout its entire length. The top of the pier having been cut to the proper angle of the pole's elevation, and the telescope cemented down, everything is complete from the instrumental side, and just such an instrument as this is now ready for use at Helsingfors. Within the last few days we have received photographs of the telescope in position, and the making of polar negatives will begin very soon

The late Miss Catherine Wolfe Bruce of New York took a great interest in the writer's proposed polar investigations, and in October, 1898, she contributed, through Professor Rees, Director of the Columbia University Observatory, funds for the construction of the new telescope, and the Russian authorities have generously undertaken the expense of a building to hold the instrument and the granite foundation upon which it rests. As soon as photographs have been secured they will be sent to Columbia University, New York, for measurement and discussion, and it is hoped they will carry out the promise of the preliminary photographs made in 1895 with a less suitable telescope of the ordinary form.—*New York Evening Post.*

It is very desirable that a large number of naked-eye observers should give systematic attention to the Gegenschein.

ANDERSON'S NEW STAR IN PERSEUS.

EDWARD C. PICKERING.

The cable message announcing the discovery of a new star in the constellation Perseus, by the Rev. T. D. Anderson, was received at the Observatory early in the evening of February 22, 1901. Owing to clouds, the new star was only occasionally visible, and twice it was necessary to cover the instruments on account of falling snow. During the intervals, however, various observations were made, which have a value owing to their early date. Numerous comparisons by Miss Cannon, with α Aurigae, magnitude 0.21, α Orionis, magnitude 0.92, and α Tauri, magnitude 1.06, showed that the magnitude of the star was about 0.9. Photometric comparisons, by Professor Wendell with the 15-inch telescope, of the Nova with the star + 43°732, magnitude 7.25, at $14^h\ 0^m$ and at $17^h\ 25^m$, Greenwich Mean Time, gave the magnitudes 0.35 and 0.39, respectively.

Meanwhile, an examination was being made, by Mrs. Fleming, of the photographs of the region obtained here earlier in the month, with the various instruments. Although photographs are taken with the transit photometer throughout every clear night, yet owing to twilight, they cannot be taken as early in the evening as this star culminates. Fortunately, for some weeks, the work of the transit photometer, which only photographs objects near the meridian, has been supplemented by photographs with Cooke and Ross-Zeiss Anastigmat lenses. With these instruments, an attempt is made to cover the entire sky, both east and west of the meridian, at short intervals. The completeness with which this has been done is shown by the fact that we have photographs of the region of the Nova with the Cooke lens on February 8, 18 and 19, and with the Ross-Zeiss lens on February 2, 6, 18 and 19. The photograph taken with the Cooke lens on February 19 had an exposure of 66^m, beginning at $11^h\ 18^m$ Greenwich Mean Time. While this photograph showed not only the faintest stars contained in the Durchmusterung, but also stars as faint as the eleventh magnitude, no trace of the Nova was seen. This result was confirmed by the other plates mentioned above. A general examination of the large number of earlier plates of this region did not seem to be necessary. Plates taken with the 8-inch Bache telescope as early as November 6, November 8, and December 12, 1887, fail to show the Nova, although the spectra of stars as faint as the eighth magnitude are clearly visible on

all, and those of the ninth magnitude on the plate taken on November 6. A photograph taken with the 24-inch Bruce telescope on October 18, 1894, with an exposure of 15^m, shows no trace of this object, although stars as faint as the magnitude 12.5 are well seen.

On this same evening, February 22, 18 photographs were taken with various instruments, under the direction of Mr. Edward S. King. They showed that, photographically, the Nova was 0.3 fainter than α Aurigae. The general appearance of the photographic spectrum resembled that of the Orion type and was very unlike that of other new stars, in which the bright lines are the most conspicuous feature. This star had a strong continuous spectrum traversed by 33 dark lines. The approximate wave lengths, as derived by Hartmann's formula, from the measures of $H\epsilon$, $H\gamma$ and $H\beta$, are given below. Each is followed by its relative intensity, and by the difference found by subtracting it from the wave length of the corresponding line, if any, in the spectrum of β Orionis. As the lines having greater wave length than 5000 have thus been determined by extrapolation, they may be subject to large systematic errors.

3894, 10, $H\zeta$, -5; 3970, 20, $H\epsilon$, 0; 4026, 3, 0; 4077, 2, -1; 4102, 30, $H\delta$, 0; 4126, 5, $+2$; 4151, 1, -4; 4266, 2, $+1$; 4341, 40, $H\gamma$, 0; 4366, 1, $+1$; 4388, 2, 0; 4415, 1; 4435, 1, $+3$; 4470, 2, $+2$; 4481, 20, 0; 4510, 2, -2; 4530, 2; 4552, 2; 4572, 1; 4616, 1; 4643, 1; 4665, 3; 4714, 3, -1; 4862, 40, $H\beta$, 0; 4885, 2; 4922, 2, 0; 5325, 1; 5399, 1; 5431, 1; 5677, 2; 5695, 7; 5719, 5; and 5761, 1. On careful examination the lines 3970, 4102, 4341, 4481 and 4862 were seen to be bright on the edge of greater wave length. The line 4665 was bright on the edge of shorter wave length, or there was a bright line whose approximate wave length was 4660. The line 4026 was not measured, but identified from its position.

On February 23, the clouds were so dense that few observations could be made. The star appeared to be brighter and bluer than α Aurigae and to have the approximate magnitude 0.0. The spectrum was photographed faintly and showed no marked change except that the line K, which was absent on the previous evening, was present and nearly as intense as $H\epsilon$.

On February 24, it became clear soon after noon, and at one o'clock the Nova was seen with the 6-inch equatorial, and also with the 2-inch finder, in strong sunlight. In the evening, the magnitude according to visual comparisons, was 0.54, from measures with the 15-inch equatorial, 0.59, and with the meri-

dian photometer, in strong daylight, 0.28. Photographically it was 0.4 or 0.5 fainter than α Aurigæ. The spectrum showed a remarkable change. It was traversed by numerous bright and dark bands, and closely resembled that of Nova Aurigæ. The principal lines were dark with accompanying bright lines of somewhat greater wave-length. The bright lines accompanying K and Hε were reversed, and traversed by narrow well defined dark lines. These lastlines and one of somewhat shorter wave-length than Hβ, are the only sharply defined lines in the spectrum, all of the others being broad and hazy, and difficult to measure with accuracy.

Clouds interfered with observations on February 25, but the Nova was evidently much fainter than on the previous evening. Its magnitude from visual comparisons was 1.4, from photometric measures, 1.07. The spectrum differed slightly from that on February 24. The lines Hδ, Hγ and Hβ were also reversed and replaced by one or more narrow dark lines.

On February 26, the magnitude from visual comparisons was 1.3, from photometric measures 1.49. The changes in the spectrum were slight.

Observations of the position of the Nova were made by Mr. J. A. Dunne, with the 8-inch meridian circle, on February 23, 24 and 25, with the result for 1900.0, R. A. $3^h\ 24^m\ 24^s.02$, Decl. $+\ 43°\ 33'\ 42''.4$.

It therefore appears that on and before February 19, 1901, the star was invisible, or at least fainter than the eleventh magnitude. On February 21, its magnitude was 2.7, according to Mr. Anderson. On February 22, its magnitude was 0.5, perhaps becoming a little brighter on February 23, and then diminishing, so that on February 25 its magnitude was 1.1. Its spectrum on February 22 and 23, was of the Orion type, nearly continuous, traversed by narrow dark lines. During the next 24 hours an extraordinary change took place, so that on February 24th the spectrum resembled that of the Novæ. It was traversed by bright and dark bands and the principal dark lines had accompanying bright lines of slightly greater wave-length.

During the last fourteen years, and since the general application of photography to astronomy, eight new stars are known to have appeared, Nova Persei, in 1887; Nova Aurigæ, in 1891; Novo Normæ, in 1893; Nova Carinæ, in 1895; Nova Centauri, in 1895; Nova Sagittarii, in 1898; Nova Aquilæ, in 1899; and Nova Persei, in 1901. The second and last of these, which were brighter than the others, were found visually by Dr. Anderson.

All of the others were found by Mrs. Fleming, from an examination of the Draper Memorial Photographs. Nova Aquilæ waannounced by telegraph, but has not been described in these circulars. Its position for 1900 is R. A. $19^h\ 15^m.3$, Decl. $-0°\ 19'$. It was not seen on plates taken on Nov. 1, 1898, and earlier, although stars of the thirteenth magnitude appeared on some of them. In July, 1900, when it was discovered, it was about twelfth magnitude. Seven bright lines, $H\zeta$, $H\epsilon$, $H\delta$, $H\gamma$, 4693, $H\beta$, and the nebular line 5007, were seen in the spectrum photographed on July 3, 1899. On September 7, 1899, $H\gamma$ and a somewhat fainter line, which is probably 4959, were the only bright lines visible. On October 27, 1899, $H\gamma$ and 5007 were alone visible and bright, so that the spectrum, had then become that of a gaseous nebula.

HARVARD COLLEGE OBSERVATORY, Circular No. 56,
February 27, 1901.

ASTRAL GEOMETRY.

GEORGE BRUCE HALSTED.

FOR POPULAR ASTRONOMY.

Schweikart, who first maintained the validity of non-Euclidean geometry for the real properties of space, called it astral geometry. W. H. S. Monck in his interesting article in POPULAR ASTRONOMY Vol. VIII, No. 6, pp. 333-6 says: "If Euclid be wrong the stars alone can prove him to be so and I think that our present knowledge of the stars has progressed far enough to throw considerable light on the subject. I should therefore be glad to hear from some non-Euclidean what are the observed facts of astronomy which are relied on as inconsistent with Euclidean geometry—a kind of geometry whose validity as regards terrestrial measurements seems to be established by ample experience."

These two sentences of Mr. Monck are so full of the popular errors about non-Euclidean geometry that they seem fitted to be the text of a sermon on this fascinating subject. Every clause embodies an error. To begin with, I do not know of any one who is maintaining that Euclid is wrong. It is the non-Euclidean geometry which has emphasized Euclid's greatness.

Under the Horseshoe Fall at Niagara press on beyond the guide, risk life for the magnificent sensation of a water spout, a cloud-burst, an avalanche, a tumbling cathedral of water-blocks.

It *must* end in an instant, this extravagant downpour of whole

wealths of water. Then out and look away down the glorious cañon, and read in that graven history that this momentary riotous chaos has been just so, precisely the same for centuries, for ages, for thousands of years.

The antithesis of these two sensations I get from Euclid in the history of mathematics.

In the flood of new discovery and rich advance, of original books and memoirs, whose mere names fill anew each year more than fifty pages of contents in the *Jahrbuch neber die Fortschritte der Mathematik*, and one-third of all which is geometry, how can anything be permanent?

Yet not only, looking back, do we see Euclid cutting his resistless way through the rock of two thousand years that make the history of the intellectual world, but also, what is more astounding, we find that the profoundest advance of the last two centuries, now called non-Euclidean geometry, is a final establishing of Euclid's unassailable perfection. "Euclid vindicated from every fleck," was the prophetic title of Saccheri's wonderful book, in which in 1733 appeared the method of treatment that has been taken as the basis of the first chapter of Manning's Non-Euclidean Geometry, just published, Boston, 1901.

The new departure, the non-Euclidean geometry is absolutely epoch-making, but fortunately it has intensified admiration for that imperishable model, already in dim antiquity a classic, the immortal *Elements* of Euclid.

Says Professor Alfred Baker of the University of Toronto:

"Of the perfection of Euclid (B. C. 290) as a scientific treatise, of the marvel that such a work could have been produced two thousand years ago, I shall not here delay to speak. I content myself with making the claim that, as an historical study, Euclid is, perhaps, the most valuable of those that are taken up in our educational institutions."

But that the ordinary triply-extended space of our experience with whose "real properties" Mr. Monck speaks of dealing, is purely Euclidean and only Euclidean, is something Mr. Monck does not know, and cannot prove, something which no one can ever know, no one can ever prove, something which never can be known, which never can be proven.

For Euclidean space the angle-sum of a rectilineal triangle must be exactly two right angles. Such absolutely exact metric results experience can never give.

In connecting a geometry with experience there is involved a process which we find in the theoretical handling of any empiri-

cal data, and which therefore should be familiarly intelligible to any scientist. The results of any observations hold good, are valid, always only within definite limits of exactitude and under particular conditions. When we set up the axioms, we put in place of these results statements of absolute precision and generality. In this idealization of the empirical data our addition is at first only restricted in its arbitrariness in so much as it must seem to approximate, must apparently fit, the supposed facts of experience, and on the other hand must introduce no logical contradiction. Thus today the ordinary triply-extended space of our experience may be purely Bolyaian, or purely Euclidean, or purely Cliffordian, or purely Riemannian as you choose. Each is, up to the present day, in simple and perfect harmony with experience, with experiment, with the properties of the solid bodies and the motions about us.

If the angle-sum of a single rectilineal triangle is exactly a straight angle, space is Euclidean; if less than a straight angle, Bolyaian; if more, Riemannian or Cliffordian.

Strangely enough, Mr. Monck seems never to have heard of Riemannian space or Cliffordian space, since he reproduces in full p. 333, Lobachevski's proof that the three angles of a plane triangle could not *exceed* two right angles, a proof which we all now know postulates and assumes the infinity of the straight line. Nor does Mr. Monck seem ever to have examined Bolyai's Science Absolute of Space, since he reproduces in full, page 334, Bertrand's pseudo-proof of the parallel-postulate, assuming that "the whole is greater than its part" is true of infinite magnitudes. That "the whole is greater than its part" does not apply in the comparison of infinites was recognized by Bolyai. [See *Halsted's Bolyai*, 4th Ed., § 24, p. 20].

Lobachevski has also given in the introduction to his "New Elements of Geometry with Complete Theory of Parallels" an exposure of the fallacy of Bertrand and Mr. Monck. [*The Neomonic Series*, Vol. V].

The mechanics of actual bodies in the external space of our experience might conceivably be shown by merely approximate measurements (the only kind that ever were) to be non-Euclidean; just as a body might be shown to weigh more than two grams or less than two grams, though it never can be shown to weigh precisely, absolutely two grams.

In this sense the Euclidean geometry is positively hopeless, in that it never can be proven, while on the contrary there was nothing theoretically absurd in the claim of C. S. Pierce to be

able to show from astronomical observations that space is non-Euclidean.

When Lobachevski exerted himself to obtain with exceeding great precision the sum of the three angles in the very largest triangles attainable for his measurement, he found this sum did not differ from two right angles by the hundredth part of a second. This shows that the space of experience approaches the ideal Euclidean space with an approximation which is very far-reaching, or, in other words, that the space-constant of the space of ordinary experience, considered as non-Euclidean, has a large value.

AUSTIN, Texas.

PHOTOGRAPHS OF THE ZODIACAL LIGHT.

A. E. DOUGLASS.

FOR POPULAR ASTRONOMY.

The accompanying photographs of the western zodiacal cone were made by the writer on February 13, 1901. The lens was made by Alvan Clark & Sons in 1899 especially for this purpose. It has the Fraunhofer curves. Its clear aperture is 0.9 inch and its focus 1.8 inches, a ratio of 1:2. The mounting used in this work is largely home made, consisting of a powerful Seth Thomas clock movement, working into a cog wheel having 120 teeth, attached to an inverted altazimuth mounting belonging to a two inch telescope.

Previous to February 13, a number of photographs had been obtained with this apparatus by exposures of an hour or more. On that date, however, trials of short exposures were made with immediate success. It appears that when the zodiacal light is at its best, exposures of eight minutes are ample; at its worst thirty minutes is required, as for the geghenschein. Impressions of the gegenschein have almost certainly been obtained but more experimenting is necessary before successful prints can be made.

Trials of some eight or ten different developers, have been made with the result, thus far, that two may be used with safety, a fairly strong Glycin developer and a Hydrochinon developer with about 25 drops of bromide solution for every 2 oz: and perhaps a few drops of a 10 per cent solution of yellow prussiate of potash. The development with the Glycin may be carried on for almost any length of time without fogging, but it is largely finished in 30 minutes. The developement in the Hydrochinon

may be continued for 30 minutes or until the plate fogs. As far as the trials go the Glycin is slightly better than the Hydrochinon.

The first negative obtained at this Observatory, showing the zodiacal light was on March 10, 1899. Many different lenses were tested and a number of satisfactory negatives were obtained of which one of the best was of the eastern cone on October 7, 1899. This was reproduced in POPULAR ASTRONOMY, No. 74, April, 1900. But the engraving did not by any means equal the photographic print. And beside that, the original exposures before the present year were all made by hand-following. This tedious work was done nearly always by Mr. W. A. Cogshall.

LOWELL OBSERVATORY, Flagstaff, Arizona.
March 11, 1901.

FIRST CHART AND CATALOGUE FOR OBSERVING NOVA PERSEI.

JOHN G. HAGEN, S. J.

This chart with catalogue has been prepared for the convenience of those who observe the Nova with the naked eye or an opera glass, and wish to determine its brightness and to reduce the same to a scale of absolute magnitudes.

While the Nova was easily identified by any one, as long as it was of the first or second magnitude, it may soon require a chart to be distinguished from the fainter stars of the neighborhood.

The catalogue gives all the stars on the chart and can be readily understood. Only the last column needs an explanation. All the stars which are decidedly yellow or reddish, have the note: Kr., which means Krueger's catalogue of colored stars, with the addition of his catalogue number and the color expressed in Schmidt's scale (0 = white, 10 = red). These colored stars recommend themselves as comparison stars, since the Nova itself has a colored tint.

The star ρ, although irregularly variable in brightness, may be used as comparison star, if its magnitude is determined at the same time by other stars. The star β or Algol can be used like any other comparison star, except on the following days, when it passes through a minimum during the evening hours: March 7, 10, 13, 27, 30, April 19, 22. A second chart is now in preparation for the time that the Nova will be invisible to the naked eye.

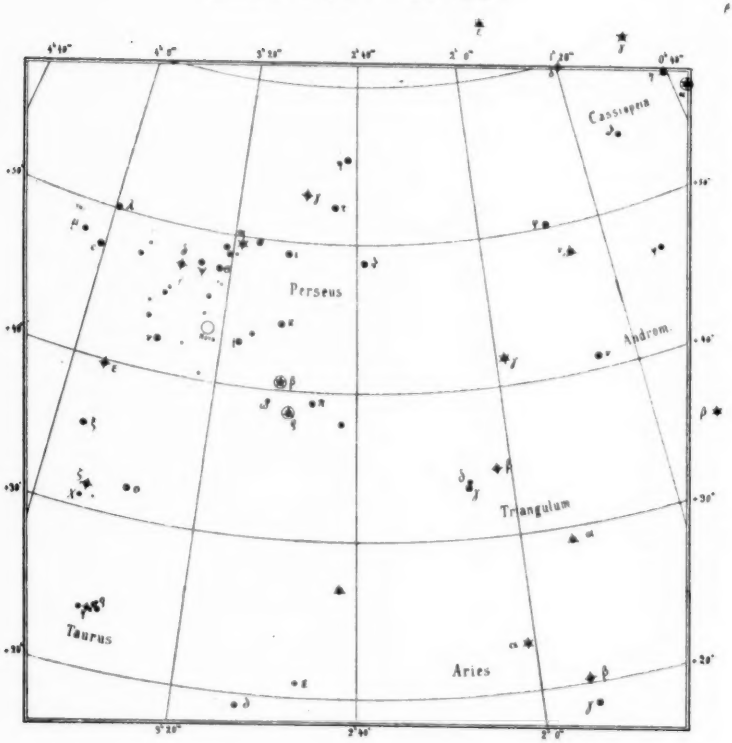
GEORGETOWN COLLEGE OBSERVATORY,
Washington, D. C., March 2, 1901.

GEORGETOWN COLLEGE OBSERVATORY.

Chart I.

Nova Persei

(1900.0) $3^h\ 24^m.4$, $+43°\ 34'$.



No	Constellation.	Bay.	Fl.	BD.	1900. R. A.	Decl.	PD.	HP.	Notes.
				°	h m	° ′			
1	Cassiopeia	β	11	+58 3	0 3.8	+58 36	2.6	2.4	
2		α	18	55 139	0 34.8	55 59	variable		$2^m.2 - 2^m.8$; $4^c.8$ Kr. 52.
3		η	24	57 150	0 43.0	57 17	3.8	3.6	
4		γ	27	59 144	0 50.7	60 11	2.5	2.2	
5		θ	33	54 236	1 5.0	54 37	4.6	4.6	
6		δ	37	59 248	1 19.3	59 43	3.0	2.8	
7		ε	45	62 320	1 47.2	63 11	3.6	3.4	
8	Andromeda	φ	42	46 275	1 3.7	46 43	4.5	4.4	
9		β	43	43 198	1 4.1	35 5	2.3	2.2	$5^c.5$ Kr. 91.
10		υ	50	40 332	1 30.9	40 54	4.3	4.1	
11		γ	57	41 395	1 57.8	41 51	2.4	2.3	$5^c.5$ Kr. 160.
12	Perseus	υ		47 467	1 31.9	48 7	3.8	3.8	51 Androm. Fl. et BAC.
13		φ		49 444	1 37.4	50 11	4.4	4.1	54 Androm. Fl. et BAC.
14		θ	13	48 746	2 37.4	48 48	4.4	4.3	
15		η	15	55 714	2 43.4	55 29		3.9	$6^c.4$ Kr. 229.
16			16	37 646	2 44.2	37 55	4.5	4.1	
17		τ	18	52 641	2 47.2	52 21	4.2	4.1	
18		π	22	39 681	2 52.4	39 16	4.9	4.5	
19		γ	23	52 654	2 57.5	53 7	3.2	3.0	
20		ρ	25	38 630	2 58.8	38 27	variable		$3^m.4 - 4^m.2$; $6^c.0$ Kr. 252.
21		β	26	40 673	3 1.7	40 34	variable		$2^m.3 - 2^m.5$.
22		ι		49 857	3 1.8	49 14	4.2	4.2	
23		κ	27	44 631	3 2.7	44 29	4.0	4.1	
24		ω	28	39 724	3 4.8	39 14	4.7	4.9	$6^c.2$ Kr. 263.
25			30	43 674	3 11.1	43 39		5.4	
26			29	49 899	3 11.5	49 51		5.3	
27			31	49 902	3 12.0	49 44		5.1	
28		1	32	42 750	3 14.7	42 58		5.1	
29		α	33	49 917	3 17.2	49 30	2.2	1.9	
30				48 913	3 18.8	48 46		6.0	
31				48 920	3 20.9	48 43		4.9	
32			34	49 945	3 22.2	49 10		4.5	
33				46 760	3 22.5	46 36			BD. $6^m.5$.
34				46 762	3 23.5	46 43			BD. $7^m.0$.
35		σ	35	47 843	3 23.5	47 39		4.5	$5^c.0$ Kr. 284.
36				40 772	3 24.9	40 25			BD. $6^m.5$.
37			36	45 778	3 25.5	45 43		5.3	
38				44 734	3 25.8	44 31		6.5	
39		ψ	37	47 857	3 29.4	47 52		4.2	
40				42 795	3 31.2	42 15			BD. $6^m.7$.
41		δ	39	47 876	3 35.8	47 28	3.3	3.1	
42				45 804	3 37.7	45 47		6.0	
43		ο	38	31 642	3 38.0	31 58	3.9	3.9	
44		ν	41	42 815	3 38.4	42 16	4.0	3.9	
45				45 811	3 39.0	45 22		5.6	
46				43 818	3 42.2	43 39		5.7	
47				44 801	3 43.1	44 40		5.8	
48				30 582	3 45.8	30 53	6.5	6.1	fundam. mag.
49				48 1015	3 46.4	48 21			BD $6^m.2$.
50		ζ	44	31 666	3 47.8	31 35	3.1	2.9	
51				47 912	3 48.8	47 35		5.3	
52		X		+30 591	3 49.1	+30 46	variable		$6\frac{1}{2}^m - 7\frac{1}{2}^m$?

No	Constellation.	Bay.	Fl.	BD.	1900. R. A.	Decl.	PD.	HP.	Notes.
				°	h m	° ′			
53		ε	45	+39 895	3 51.1	+39 43	3.2	2.9	
54		ξ	46	36 775	3 52.5	35 30	4.3	4.1	
55		λ	47	49 1101	3 59.1	50 5	4.5	4.2	
56		*c*	48	47 939	4 1.4	47 27	4.4	3.9	
57		μ	51	48 1063	4 7.6	48 9	4.3	4.3	
58	Triangulum	α	2	28 312	1 47.4	29 6	3.7	3.6	
59		β	4	34 381	2 3.6	34 31	3.3	3.0	
60		δ	8	33 395	2 10.9	33 47	5.1	5.1	
61		γ	9	33 397	2 11.4	33 23	4.3	4.1	
62	Aries	γ	5	18 243	1 48.0	18 48	4.2	3.9	UA. $3^m.8$.
63		β	6	20 306	1 49.1	20 19	3.0	2.8	UA. 2 .7.
64		α	13	22 306	2 1.5	22 59	2.2	2.2	
65			41	26 471	2 44.1	26 51	3.7	3.6	
66		ε	48	20 484	2 53.5	20 56	4.8	4.7	UA. 5.0.
67		δ	57	19 477	3 5.9	19 21	4.7	4.6	
68	Taurus		17	23 507	3 38.9	23 48	4.1	3.8	
69		*q*	19	24 547	3 39.3	24 10	4.6	4.3	
70			20	23 516	3 39.9	24 4	4.2	4.1	
71			23	23 522	3 40.4	23 38	4.4	4.3	
72		η	25	23 541	3 41.5	23 48	3.1	3.0	
73			27	+23 557	3 43.2	+22 45	4.0	3.9	

TIDAL FRICTION AND PLANETARY ROTATIONS.

ISAAC E. CHRISTIAN.

For Popular Astronomy.

In order to determine the cause of the rotary motions of the planets, as well as the cause of the inclinations of their various axes toward the planes of their orbits, it seems necessary to go back to the earlier stages of their development, when they existed as vast spherical bodies of highly expanded planetary matter revolving in their orbits around the Sun.

At this stage of their development, it is obvious that on account of their enormous dimensions and their consequent low superficial gravity, the action of the Sun's attraction must have raised immense tidal protuberances on them in the tenuous gases with which they were surrounded.

It is also obvious that these gaseous tides necessarily moved entirely around these vast bodies in the planes of their orbits and in the direction of their orbital motions once during each revolution around the Sun.

The friction therefore of these tides against the more unyielding parts of these planetary bodies of heterogeneous matter, it seems

to me must necessarily have tended to gradually bring about slow rotary motions on their axes, so that eventually they must have rotated on their axes on this account about once during each revolution around the Sun.

After the separation of the satellites from the bodies of the planets, the tides raised by their action on their respective primaries must necessarily have tended to gradually accelerate the motions already induced by the tides raised by the Sun's action until they ultimately rotated on their axes about once during each revolution of their satellites.

In this way it seems to me beyond doubt, the rotary motions of the vast bodies of matter from which the different planets have since been formed were first imparted to them, and from these slow primary rotations of these original bodies, the present rapid rotations of the resultant planets can easily be accounted for by the great amount of contraction which has since then taken place in their dimensions.

If these conclusions are correct however it seems to follow that the planets must have originally rotated on their axes in the planes of their orbits and in the direction of their orbital motions, and in order to explain why they have not continued to do so it appears that we must again have recourse to the disturbing action of the tides.

* * * * * * * * * *

It will be noticed as already indicated that so long as the tides moved around the planets faster than they rotated on their axes, they tended to gradually accelerate their rotations; their friction in such cases being continuously converted into rotational energy.

As soon however as the contraction of the planets caused them to rotate on their axes faster than the tides moved around them, then their friction, instead of accelerating their rotations began to retard them, thus slowly robbing the planets of the very energy which they had been perhaps millions of years in imparting to them.

It is a well known fact that the rotational energy of the Earth is being slowly diminished in this way at the present time.

The fact however that the action of the tides, not only tends to diminish the Earth's rotational energy but in certain cases also tends to cause her to change the direction of her axis, has so far apparently escaped the notice of those who have given the matter their attention. A careful investigation of the matter however leaves it scarcely to be doubted that such is really the case.

Of course in cases where the friction of the tides against a con-

tinent or an island on one side of the equator is exactly balanced by a like friction on the other side of it there is no tendency to change the direction of the plane of the Earth's rotations, but in cases where tidal friction is exerted against a body of land on one side of the equator and there is no corresponding friction on the other side to counteract it, then in addition to its tendency to retard the Earth's rotations it also tends to change the direction of her axis.

It also seems that in cases where the outline of the coast extends diagonally to the direction of the tides, so that the tide waves strike it obliquely and are deflected from their original course, the reaction would tend to cause a change in the direction of the Earth's axis.

Now in regard to the planets, it is quite certain that during the various stages of development through which they have passed, the friction of the tides has often been exerted for long periods of time against their rigid parts on one side of their equators without any corresponding friction on the other side to counteract it. The Earth at the present time meets with perhaps twice the amount of resistance to her rotations by tidal friction against the various bodies of land on the northern side of her equator that she does on the southern side of it, and it is reasonable to assume that similar conditions have prevailed on the other planets during the different stages of their development.

The resistance of the tides exerted in this way for long periods of time against the rigid parts of the planets on one side of their equators without being counterbalanced by a like friction on the other side would not only tend to slowly diminish their rotational energy, but would also necessarily bring about a gradual change in the direction of their rotary motions, so that eventually their axes of rotation would all become more or less inclined toward the planes of their orbits, just as observation shows them to be at the present time.

This tendency of the planets to change the direction of their axes on account of the action of the tides, is to a certain extent counteracted and kept within certain limits by the action of the Sun's attraction on the rings of protuberant matter around their equatorial diameters, caused by the centrifugal force of their rotations. In the case of Uranus and Neptune however this action of the Sun on their equatorial protuberances is very feeble and as a consequence we find a change of more than ninety degrees in the original direction of the axes of these planets.

OCEANA, W. Va.

THE NEW STAR IN PERSEUS.

H. C. WILSON.

This new star—what is it? Where is it? When was it discovered? How bright is it? Is it really a new star, or was there a faint star in its place before? How long will it last? How do you account for it? These are questions which have been put to the writer, and doubtless to every other astronomer, over and over again in quick succession during the past three weeks. Some of them are easy to answer, others are beyond the powers of human intelligence at the present time.

To a casual observer, looking at the sky on a clear, moonless night, the glittering star points seem countless, and the accession of one more would seem to be scarcely noticeable, unless it should be exceedingly brilliant. It was however the appearance of just such a star that led to the preparation of the first accurate maps of the sky, and when this came to be done it was found that the stars visible to the eye were not innumerable, not more than 2,000 to 2,500 being visible to the average eye at one time. Of these not more than 300 are at all conspicuous, and they are arranged in such groups, that any one may in a short time so familiarize himself with each group or constellation, as to recognize at a glance any new comet. For example there are few persons who are not so familiar with the group of stars called the Great Dipper, which is now over head at 9 o'clock in the evening, that they would not at once notice any new bright star which might appear within the bowl of that figure.

The new star in Perseus is a star which suddenly appeared near the middle of the constellation Perseus at a point where no star was visible before. It is almost exactly at the center of the isosceles triangle formed by the stars α, β and ϵ, and two-fifths of the way from ν to κ (See our chart of the constellations for this month or last). Its exact position has been determined by meridian observations at several Observatories. At Harvard the observations on three nights gave the star's position for 1900.0 as R. A. $3^h\ 24^m\ 24^s.02$, Decl. $+\ 43^\circ\ 33'\ 42''.4$.

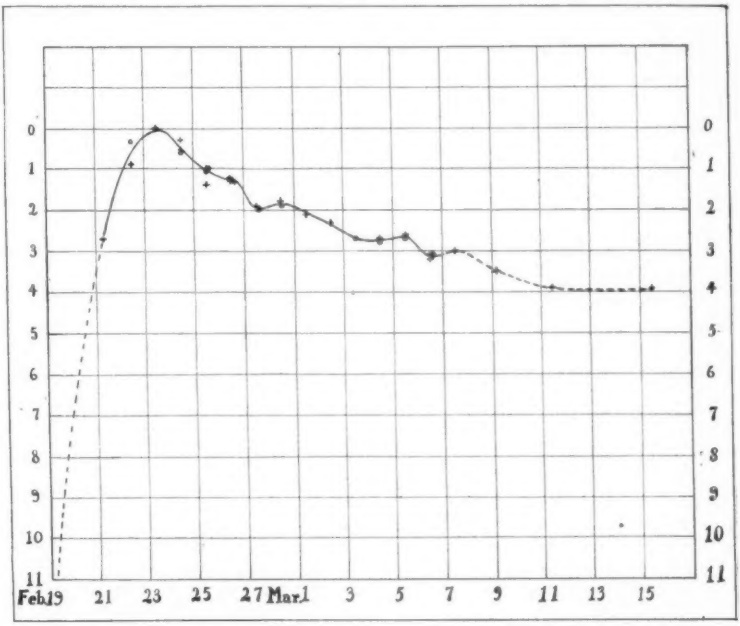
It was discovered on the evening of Feb. 21 by Rev. T. D. Anderson, of Edinburgh, Scotland, a well-known amateur astronomer, who devotes his attention especially to the study of variable stars and has during the last decade discovered a large number of new variables. He was the first to discover the new star in Auriga in 1892. Several other persons noticed the new star in

Perseus on the night of Feb. 22 before receiving the notice of Mr. Anderson's discovery. The star appears then to have been rapidly increasing in brightness, Mr. Anderson recording its magnitude on Feb. 21 as 2.7, the Harvard observers making it 0.5^m on Feb. 22 and still brighter on the 23d. On Feb. 24 it had begun to wane and it has continued to decline with some fluctuations until now (March 16) it is of the 4th magnitude. If the history of previous new stars is to be our guide, the decline of the star's light will continue until within probably a year or two it will no longer be visible in the largest telescopes. The following is a list of the estimates which have come to hand of the star's brightness:

	Magnitude.	Observer.
Feb. 21	2.7	Anderson.
22	0.9	Miss Cannon, Harvard, visual.
22	0.37	Mr. Wendell, Harvard, photometric.
23	0.0±	Harvard observers, visual.
24	0.54	Harvard, visual.
24	0.59	Harvard, photometric.
24	0.4	Upton, Ladd Observatory.
25	1.4	Harvard, visual.
25	1.07	Harvard, photometric.
25	1.0	Upton.
25	1.0	Parkhurst, Yerkes Observatory, photometric.
26	1.3	Harvard.
26	1.2	Upton.
26	1.1	Parkhurst.
26	1.1	Wilson, Goodsell Observatory.
27	1.9	Upton.
27	2.0	Parkhurst.
27	2.0	Wilson.
28	1.8	Upton.
28	1.9	Parkhurst.
Mar. 1	2.1	Upton.
2	2 3	Wilson.
3	2.7	Parkhurst.
4	2.8	Parkhurst.
4	2.7	Wilson.
5	2.7	Parkhurst.
5	2.6	Wilson.
6	3.2	Upton.
6	3.1	Parkhurst.
6	3.1	Wilson.
7	3.0	Upton.
9	3.5±	Wilson.
11	3.9	Wilson.
15	3.9	Wilson.
16	4.0	Payne.

These estimates, with the exception of the last, have been platted upon the accompanying diagram. The visual estimates are represented by crosses and the photometric measures by circles. The agreement between the different estimates on the same night is very satisfactory and the fluctuation indicated in the light curve would seem therefore to be real.

Is it really a new star? This is not so easily answered as the preceding questions. Yet we can say pretty safely that there has been no star visible with the aid of an ordinary telescope, in the



THE LIGHT CURVE OF NOVA PERSEI.

place of the Nova, for a number of years back. Photographs taken at Goodsell Observatory on Aug. 27 and Sept. 26, 1900, with the 2½ inch Darlot lens, cover the region of the new star and show stars down to the 11th magnitude in its vicinity, but show no trace of a star in its exact position. A four hour exposure with the same lens on Oct. 16, 1895, has the region of the Nova near the edge of the field, where the distortion of the images is great, but even here a star of the 13th magnitude would be clearly shown. On this plate there is the slightest trace of a stain in the place of the new star, but it is probably due to some other cause than starlight.

The systematic photographic survey of the heavens carried on at Harvard College Observatory enables us to go further and say that as late as Feb. 19, 1901, two days before the discovery, the Nova was not as bright as the 11th magnitude. A photograph taken on Feb. 19 with an exposure of 66^{m}, beginning at 11^{h} 18^{m}

Greenwich mean time, shows stars of the 11th magnitude, but no trace of the new star. Other photographs Feb. 2, 6, 8 and 18 give the same result.

We have thus the startling phenomenon of a star rising from invisibility and in three days, at most, becoming one of the most brilliant in the heavens, then gradually disappearing. Such phenomena are extremely rare, this star being the brightest of its kind, so far as known certainly, since the famous one observed by Tycho Brahe in Cassiopeia in 1572. Lesser outbursts may have been frequent and escaped notice, and the fact to which Professor Pickering calls attention in *Circular No. 56 of Harvard College Observatory*, that eight new stars have been discovered in the last fourteen years, since photographic processes have been so generally applied to astronomical research, points to this conclusion. In the future many such sudden outbursts may occur and being promptly detected and studied with photometer and spectroscope furnish the data for their interpretation. Such bright new stars as this one, however, will always be rare, and we are exceedingly fortunate in having it discovered so immediately on its appearance.

How to account for it? This is a mystery which it is impossible to solve with certainty. It is evident that we are here in the presence of a tremendous catastrophe, it may be of creation, of evolution or of destruction. So far as has been determined, the distances of temporary stars are of the same order as those of the fixed stars, so that it takes years for their light to reach us. At such vast distances, it is evident that the forces in play to produce such an enormous outburst of light must be grand almost beyond conception.

Various theories have been suggested to account for temporary stars. One is that two suns or stars, once hot and brilliant, but since grown cold and dark, have come into collision. If such a thing should happen, the energy of motion, as the two bodies meet with the tremendous velocities generated by their mutual attraction, would be converted into thermal energy, fusing or vaporizing all substances near the points of impact and perhaps breaking the crusts of the stars and liberating pent up gases from within.

Lockyer supposes two vast swarms of meteoritic particles, flying in different directions, to meet in space, and the millions of collisions of separate particles, as the two swarms pass through each other, to generate heat and to liberate and cause to glow the various vapors.

Zöllner in 1865, before the spectroscope had been applied to the observation of new stars advanced a theory based upon the observations of Tycho Brahe's star in 1572. He assumes a star sufficiently cooled off to have formed a dark crust. Some accident, perhaps the natural shrinkage of the crust due to radiation causes a rent in the crust and the pent up glowing matter bursts forth from within and, by its glow together with that produced by chemical union with particles in the atmosphere of the body, generates a great outburst of light.

Still another theory, advanced by Klinkerfues to explain certain variable stars and adapted by Wilsing to temporary stars, is that the two components of a binary star, moving in very eccentric orbits, do not actually come into collision, but approach so near at periastron that the tidal effect greatly distorts the atmospheres of the stars, uncovering portions of the surface whose light was before almost wholly absorbed by the surrounding atmosphere. The tidal effect in the interior of the stars may also be so great as to cause molten matter and incandescent vapors to burst through the crust, thus augmenting very greatly the brightness of the bodies. The direct tidal action could last only a few hours, but the reflex oscillatory action resulting from it might last for a long time.

Perhaps the best theory is that of Seeliger, given in Frost's translation of *Scheiner's Astronomical Spectroscopy*, page 298. In this a dark body is supposed to pass through a nebula or cosmic cloud of dark matter. Such clouds of matter, very faintly luminous, are known to exist in various parts of the sky and their extent is so enormous that the entrance of a star into one of these is much more probable than the collision of two stars.

"However rare the matter in the cloud may be, and whatever its physical condition—whether dust-like, liquid or gaseous—an intense superficial heating of the visiting body will result, with the vaporization of its outer portions. These vaporized portions will in part soon detach themselves and rapidly assume the velocities of the portions of the cloud through which they are moving. We shall therefore obtain two superposed spectra, the one due to the incandescent body being continuous, and crossed by dark bands caused by the absorbing vapors surrounding it, while the other spectrum will chiefly consist of bright lines. The two spectra will be relatively displaced in proportion to the relative velocities in the sight-line.

"It is not necessary to assume that the original relative velocities of the cosmical cloud and the dark star were very large. As

the star approached the cloud, the latter would extend out to meet it, the relative velocities of the individual cloud particles in the direction toward the star thus rapidly increasing as the two bodies came into near proximity. Supposing that the cloud is so constituted that its particles become chiefly subject to the action of the entering body, they will then describe hyperbolas about it as a focus and will accordingly have very different velocities among themselves, so that their bright lines will be broad, diffuse and liable to any of the peculiarities actually displayed in the spectrum of Nova Aurigæ.

"As long as the body remained within the cloud, variations in its brightness and in its spectroscopic condition would repeatedly occur, but the decline of its brightness would naturally be slow until it emerged from the cloud, and thereafter rapid—which would agree with the observed facts."

The spectrum of Nova Persei now resembles that of Nova Aurigæ, but has changed greatly since the discovery of the star. As observed on Feb. 22 at Edinburgh and at Harvard College Observatory the spectrum was continuous with a number of fine dark lines. Copeland at Edinburgh puts the number of fine dark lines at a half dozen, while Pickering from the photographs at Harvard, states that there were 35 dark lines. On the 23rd at Harvard little change was noticed, but on the 24th the change was remarkable. According to Pickering the spectrum was then traversed by numerous bright and dark bands, and closely resembled that of Nova Aurigæ.

On the 25th the observations at the Solar Physics Observatory South Kensington led Sir Norman Lockyer to give the following statement, quoted in *Nature*, Feb. 28, from the London *Times*:

(1). The spectrum strongly recalls that of Nova Aurigæ.

(2). There are at least two light sources involved; one with a dark-line spectrum, the other giving chiefly the bright lines of hydrogen, helium, asterium and calcium.

(3). Some of the bright lines are probably reversed.

(4). The broadening of the bright lines is considerably greater than that observed in Nova Aurigæ.

(5). It has been determined by a comparison spectrum of Bellatrix, on the same plate, that the middle of the bright lines occupies nearly the normal position in the spectrum; the greatest breadth of lines observed extends over some 30 tenth-metres.

(6). The centres of the bright and dark lines are separated by about 15 tenth-metres, showing a differential velocity of somewhere about 700 miles per second between the colliding light sources.

Our first observations at Northfield were on Feb. 26. The spectrum photographed with the 16-inch telescope and 60° prism, using no slit but allowing the driving clock to run a little too fast and thus lengthen the lines of the spectrum, seems to be composed of very broad bright lines, each one more intense near its more refrangible edge (toward the violet), and accompanied on that side by a broad dark space except where the brighter lines crowd each other. Fifteen such lines can be counted from $F(H\beta)$ to K and three from F toward the red end of the spectrum. The brightest lines are all very broad; about 40 tenth-meters wide. Half way between $H\beta$ and $H\gamma$ a number of almost equally bright lines overlap each other so as to give the appearance of a nearly continuous spectrum. Visually the red end of the spectrum was stronger than the blue, $C(H\alpha)$ being the most vivid of all the bright bands. Another strong bright line or band was seen in the yellow.

On Feb. 27, with a moderately narrow slit, the photograph shows better defined bright lines but they are still very broad and most of those which are separate from each other are clearly triple, having two narrow dark lines superposed upon them. The comparison with the spectrum of the Moon photographed upon the same plate shows that the middle component of each bright line coincides very nearly with the corresponding dark line in the solar spectrum. There is a small deviation toward the red, showing probably that the source of the bright lines is moving away from us at a moderate velocity. Later photographs taken Mar. 9, 11 and 15 give a little less width to the bright hydrogen lines and bring out more definitely the dark absorption line, of perhaps 10 tenth-meters width, on the more refrangible (blue) side of each. The last three photographs were taken on Cramer isochromatic plates and extend the photographed spectrum down to about the D lines. Four strong bright bands are shown in the green and yellow besides those shown on the other plates.

A comparison of the five photographs shows marked changes in the appearance of the lines. The hydrogen $H\gamma$ shows these changes most plainly, its image being of such intensity that the details of its structure are best shown, but so far as I can tell the other lines indicate the same changes, modified somewhat by their position with reference to the curve of sensitiveness of the plate used. Designating the three bright components by a, b and c, and the dark component by d, the order of the letters expressing the order of the refrangibility, the following notes will indicate the more evident changes:

Feb. 26. Division between components indistinct; component *c* most intense.

Feb. 27. Divisions distinct; component *c* most intense; *a* and *b* equal in intensity and width; *d* overlaps about one-third of *c*.

Mar. 9. Components nearly equal in intensity; *c* clearly separated from *b*; no division between *a* and *b*; *d* strong.

Mar. 11. *c* clearly separated from *b*; *a* and *b* united and more intense than *c*; d strong.

Mar. 15. *c* much fainter; *a* and *b* united and much stronger than *c*; *d* has apparently covered *c*.

We are not provided with a measuring machine, and so cannot as yet determine the exact wave-lengths of the lines, but mere inspection of the photographs, in comparison with Rowland's maps of the solar spectrum, shows that the motions of the sources of the four components, if their divergence is to be attributed to motion, must be enormous. The centers of the components are almost equidistant, that is 15 tenth-meters apart. Supposing the source of *b* to be stationary, since this component coincides nearly with the hydrogen line in the solar spectrum, the source of *a* must be moving away from us with a velocity of between 600 and 700 miles per second while that of *c* is approaching with nearly the same velocity. The cool matter which produces the dark component *d* must be approaching with the still more incomprehensible speed of upwards of 1000 miles per second.

ECLIPSE CYCLONES.

"The low temperature, the circulation of the winds, and the form of the pressure-curve accompanying the eclipses of May 28, 1900, all proclaim the development by the eclipse of a cold-air cyclone, the theory of which has been so well worked out by Ferrel that no better description of it could be given than in his own words. Ferrel maintains, from theoretical considerations, that cyclones necessarily have an inner area of low pressure, surrounded by a ring of high pressure which Professor W. M. Davis has named a *pericyclone*. Ferrel further maintains that a cyclone may have its origin either in a high air temperature increasing toward a central area. The one he calls a cyclone with a warm centre, the other a cyclone with a cold centre. Of cyclones with a cold centre, he says:

"If for any reason the central part of any given portion of the

atmosphere of a somewhat circular form is maintained in any way at a lower temperature than the surrounding parts, and the temperature gradient on all sides is somewhat symmetrical, we have approximately the conditions which give rise to a cyclone. In this case it is readily seen that there must be a vertical circulation, as in the ordinary cyclone, but that it is reversed, out from the centre below and in toward the centre above, with a gradual settling down of the air in the interior to supply the outward current beneath. This vertical circulation, as in the case of the ordinary cyclone, gives rise to a cyclonic motion in the interior and an anticyclonic in the exterior part of the air under consideration, but in this case the gyratory velocity is greatest above and is less at lower altitudes, diminishing down to the Earth's surface, where it is least. In the anticyclonic part the reverse takes place, the gyratory velocity being least above and greatest down near the Earth's surface. The distance from the centre, at which the gyratory velocity vanishes and changes sign, is greatest above, and gradually becomes less, with decrease of altitude down to the surface, where it is nearest the centre. . . The conditions of a cyclone with a cold centre which are the most nearly perfect, are those furnished by each hemisphere of the globe, as divided by the equator, in which the pole is the cold centre and the temperature gradient from the pole toward the equator is somewhat symmetrical in all directions from the centre. . . . The easterly motions in the higher latitudes and the westerly ones in the lower latitudes, in the one case, correspond to the cyclonic in the interior and the anticyclonic in the exterior part, and the belt of high pressure near the tropics to that of high pressure in the case of any cyclone with a cold centre. . . . The centre of a cyclone with a cold centre may, or may not, have a minimum pressure, according to circumstances. A certain amount of temperature gradient, and of pressure gradient which is independent of the gyratory motion, as explained in the case of the general circulation of the atmosphere, is necessary to overcome the friction in the lower strata and to keep up the vertical circulation, upon which the cyclone depends; and the pressure gradient, which depends upon the temperature gradient and is independent of the gyrations, may be such that the increase of pressure in the central part due to this cause may be greater than the decrease of pressure arising from the cyclonic gyrations, especially where surface friction is great." (*A Popular Treatise on the Winds*, pp. 337-329).

The eclipse-cyclone is of especial interest from a theoretical

point of view, because its origin, clearly connected with the fall of air-temperature attending the eclipse, is freed from all questions relating to the condensation of vapor, and from all questions relating to the dynamic effects due to the meeting of air-currents which might possibly influence the origin of the ordinary cyclone. The eclipse may be compared to an experiment by Nature in which all the causes that complicate the origin of the ordinary cyclone are eliminated, except that of a direct and rapid change of temperature. The results derived from the observations, by eliminating the influence of other known phenomena, show quantitatively the effects of a given fall of temperature near the Earth's surface in a given time. They show that a fall of temperature is capable of developing a cold-air cyclone in an astonishingly short time, with all the peculiar circulation of winds and distribution of pressure that constitute such a cyclone. They show, furthermore, that a fall of temperature of the air does not act primarily to cause an anticyclone but a cyclone, and the anticyclone is a secondary phenomenon, or rather a part of the cyclone.

The eclipse-cyclone shows no apparent lag, or dynamic effect, due to the inertia of the air. To keep pace with the eclipse-shadow, moving about 2,000 miles an hour, the eclipse-cyclone must have formed continuously within the shadow and must have dissipated in the rear almost instantly. In this way its motion may be considered to have a certain analogy to wave-motion. Any given particle of air, moving with the velocity of the eclipse-winds, could not have moved more than five miles as a maximum during the passage of the eclipse. Hence all the changes of pressure must have been derived from the deflective influence of the Earth's rotation, acting on air moving this distance.

In brief, the meteorological effects of the eclipse are important: (1) because they confirm so well Ferrel's theory of the cold-air cyclone; (2) because they show the wonderful rapidity with which cyclonic phenomena can develop and dissipate in the atmosphere; and (3) because they show that cyclones do not necessarily drift with the atmosphere, but move with their originating cause, which, in the eclipse, had a progressive velocity of about 2,000 miles an hour.—*H. C. O. Annals, Vol. XLIII, Pt. I.*

On March 23, 1901 we received word from S. W. Burnham that the Washington eclipse party bound for Sumatra had reached Honolulu. Word came from E. E. Barnard by letter to Chicago.

NORTHERN AND SOUTHERN LIGHTS ILLUMINATING THE HEAVENS AT THE SAME TIME.*

I.

In a letter published in the December number of the *Geographical Journal* (London), Mr. Arthur Harvey, an ex-president of the Canadian Institute, has made some very interesting remarks on the correlation which exists between the aurorae boreales observed at Toronto in March and September, 1898, and the aurorae australes which I observed on the Belgica, in the Antarctic polar ice.

I am much obliged to Mr. Arthur Harvey for having considered my short paper in the *Geographical Journal*, and for having shown, once again, how great is the interest offered by the physical phenomena of our planet, when studied from the geographical standpoint.

I have already drawn the attention of the readers of *Ciel et Terre* to a remarkable analogy I observed between the results of auroral observations made by Baron Nordenskjold, on the Vega, in the north, and my observations of the southern aurorae, and I intended discussing the subject at length in the scientific reports of the Belgian Antarctic Expedition. Nevertheless, as Mr. Arthur Harvey has at his control documents much more important than those at my disposition, I must ask him to study, from his position, the observations which the Belgica commission will soon publish.

As to the magnetic observations, the preliminary notice of Mr. Lecointe's, in the bulletin of the Belgian Academy, 1900, pages 179-193, will have to be considered, and as I have already published a discription of one of the aurorae australes, observed in September (*Ciel et Terre*, January 1st, 1901), I embrace this opportunity to print all my observations for that month, so that it may be possible to verify at once if there was a simultaneity of the auroral phenomenon in both hemispheres.

In my remarks upon the analogy between the northern and southern aurorae, I only insisted to a limited extent upon the probable identity of the geographical distribution of the auroral phenomena (with respect to the magnetic poles), and I placed a point of interrogation on the subject of all the other analogies which will doubtless be hereafter found. But now comes Mr.

* The article is a translation of one written by H. Arctowski of the Belgica. Arctic Exposition, and published in *Ciel et Terre* a scientific journal of Belgium Mr. Arthur Harvey who is referred to in it has kindly sent this communication which appeared in the *Mail and Empire*, March 2, 1901.

Harvey, who shows us a remarkable agreement between the aurorae observed in 1898 in Canada and the Northern United States, and those I recorded in the Antarctic.

He compares two series of observations with those of the Belgica. They are those given in the reports of the United States Weather Bureau, and those of the Weather Review, published at Toronto. The latter are classified, according to their intensity, into aurorae of the first, second third and fourth orders, and the ordinates of Mr. Harvey's curves are proportioned by those figures. The comparison shows the concomitance of aurorae in the north and in the south, as also of the magnectic storms recorded at the Toronto Observatory.

There is one fact which makes the comparison between the Toronto observations and those of the Belgica particularly interesting: The longitudes in which the Belgica was during the months of the Antarctic winter differ but little from the longitude of Toronto. Thus, in September, the Belgica was drifting between the 82d and the 83rd degrees of longitude, which is only 4 degrees different from Toronto. The hour is therefore nearly alike on the Belgica and at Toronto. But in March the difference was ten degrees, which makes forty minutes difference in time.

The curves in Mr. Harvey's diagram show that the dates correspond, that is on the same days, we were observing, in the north as in the south, polar aurorae more or less developed.

But I think it would be interesting to follow the comparison further, and to see if, during these same aurorae, there were similar fluctuations of the curves of intensity, if, in other words, similar phases of the development of the aurorae boreales at Toronto occurred at the same instant as those in the southern aurorae. The diurnal agreement makes a similar comparison quite specially interesting between two geographical points situated on one same meridian, such as Toronto and the Belgica—or, should it perhaps be on the same magnetic meridian? The comparison will be instructive.

In any case my observations are in sufficient detail to make a comparison with simultaneous aurorae at various points in Canada and the United States possible. If the observations of the aurorae have been made at Toronto in a careful, consecutive way, we shall have the first data for the identification of the phenomenon in two hemispheres.

II.

Here are given detailed accounts of the aurorae of September

1st and 2nd, 5th and 6th, 9th, 10th and 11th; observations being usually noted every fifteen minutes.

III.

In my first paper on aurorae australes I said:—"We want to know if there be a perfect similitude in the appearance of polar aurorae in both hemispheres, if their distribution with respect to the magnetic poles is analagous, if the periods are the same and if they coincide, and finally if the two phenomena are simultaneous. To none of these questions could we at present give a definite reply. To identify the southern with the northern aurorae, we need several series of observations made in both hemispheres, in corresponding geographical points."

But now that we have found observations made at two corresponding geographical points, let us use the data we possess.

The aurorae of the 2nd and the 9th of September, 1898, will suffice, provisionally, to see if there was a perfect agreement in the development of these aurorae, north and south, respectively. I do not mean to say that at the same moment there can be the same particular features; the aspect of the aurorae boreales varies sensibly at different points of observation. It does not generally show at the same moment all around the magnetic pole, its principal centre of development seems to move progressively, following the Sun in its course.

It is surprising that in spite of the many observations made during the years of international polar observations, 1882-3, no study was made of the geographical distribution of one given aurora and of the different phases it presented at different points of observation. But, not having such data, let us now enquire if the duration of the aurorae of 2nd and of 9th of September 1898, was the same and to the north of the United States, as in the region where the Belgica was drifting—also, if the fluctuations in intensity were the same in the north as in the south. Also, if the maxima and minima correspond to the same instant, and if at two points equi-distant from the magnetic poles, and situated on the same meridian the height of the aurorae axes was similar.

SPECTROSCOPIC NOTES.

The establishment of an Observatory for astrophysics and meteorology at a high altitude on one of the summits near Semmering, about fifty miles southwest of Vienna, is a project of which Herr Kostersitz has given to the *Astronomische Gesellschaft* an enthusiastic account (*Vierteljahrsschrift*, Bd. 35, Heft 4). An altitude of about 6000 feet above sea level can be obtained, at which the sky

is often found to be entirely clear although clouds fill the valleys below. Detailed plans are given of the proposed structure, in which are included a dome 15 meters (50 feet) in diameter for a large refractor, a smaller dome 10 meters (32 feet) in diameter for a photographic telescope, and a laboratory for spectroscopy.

It is announced that Dr. Paschen, whose recent spectroscopic work is well known, has been appointed Professor of Physics in the University at Tübingen.

Herr Belopolsky (*Astronomische Nachrichten No. 3682*) has called the attention of spectroscopic observers to the star ϵ Pegasi, in whose motion in the line of his measures seem to show a variation in as short a time as one day. The star's spectrum resembles that of Sirius, with heavy hydrogen lines and narrow iron lines.

A small portion of M. Maunder's account of the Greenwich Observatory (*The Royal Observatory Greenwich* by E. Walter Maunder, London, 1900) is devoted to a description and history of the rather unsatisfactory spectroscopic department. Work on motions of stars in the line of sight, clearly within the object of exact measures of the Observatory foundation, was begun on the 13-inch equatorial in 1875, and was discontinued in 1891 when this telescope made way for the 28-inch. The new spectroscope, designed for the Thompson photographic refractor, now attached to the 30-inch reflector, is used for observing planetary and cometary spectra, but not yet for regular work. The daily mapping of prominences as a complement of heliographic work, and examination of spot spectra as a complement of magnetic and heliographic work, have been discontinued, rather unfortunately, by reason of unfavorable atmospheric conditions and of lack of help. The future of the spectroscopic work of the Observatory is uncertain.

In a paper read before the Royal Astronomical Society Dec. 14, presenting the results of his comparison of magnetic records with records of sunspot phenomena, Father Sidgreaves gives a summary of Mr. Townsend's observations of the hydrogen line in the red and a comparison of the dates of observed solar activity in the years 1892-6 with the dates of magnetic storms. Of the 231 dates of solar activity only 53, and of the 41 dates of marked solar activity only 7, were accompanied by magnetic disturbances.

The binary star ζ Herculis is the subject of an investigation by M. Lewis (*Monthly Notices*, Dec.; *Observatory*, Jan.) in the course of which he compared the apparent orbit with the Greenwich meridian circle measures of the absolute motion of the brighter component, and detected in the latter a motion just half of the apparent orbital motion; thus demonstrating the equality in mass of the components of the third and sixth magnitudes. He further used the spectroscopic measures of motion of the bright component in the line of sight to deduce the star's parallax, obtaining the rather large value $0''.14$.

A grant has been made from the Draper fund of the National Academy of Sciences for the purpose of constructing a modern one-prism spectrograph for the Lick Observatory, which is expected to replace the imperfect instruments now used in photographing faint spectra.

The Council of the Astronomical and Astrophysical Society, according to an announcement in *Science*, Feb. 15, have withdrawn the arrangement for a meeting next summer in Denver, and have substituted a plan for a meeting during the Christmas holidays in Washington.

The director of the Lick Observatory announces (*Publications of the Astronomical Society of the Pacific*, No. 77) that no regular spectroscopic observer will accompany the expedition from the Lick Observatory to Sumatra to observe the eclipse of May 18, but that one or two simple spectroscopes will be taken.

The spectrum of Nova Persei is of the usual type, a continuous specturm with the broad hydrogen and helium lines consisting each of a bright component toward the red and a dark component toward the violet. The spectrum is a very striking one with a small spectroscope, the bright *C* line in particular being quite conspicuous, but the D_3 line much less prominent. The extraordinary brightness of the star makes the opportunity a splendid one for the detailed study of this interesting and important type of spectrum.

PLANET NOTES FOR APRIL.

H. C. WILSON.

Mercury will be at greatest elongation, west from the Sun 28° 48′, on the morning of April 4 and so will be visible as morning star during the first half of the month.

Venus will be at superior conjunction April 30. On April 1 the planet will be only about 5° west and 4° south from the Sun, so that it will probably not be visible to the eye during the month.

Mars is at its best in the early evening, shining with a brilliant ruddy light, far exceeding the brightness of the stars of Leo near it. The westerly motion with reference to these stars has been very noticeable during the past month. On April 5 Mars will be stationary in right ascension and after that will move eastward. It will, however, continue to be west of Regulus during all of this month.

Jupiter is at quadrature, 90° west from the Sun, April 1 and may be observed in the morning twilight toward the southeast. Its low altitude will prevent very satisfactory views.

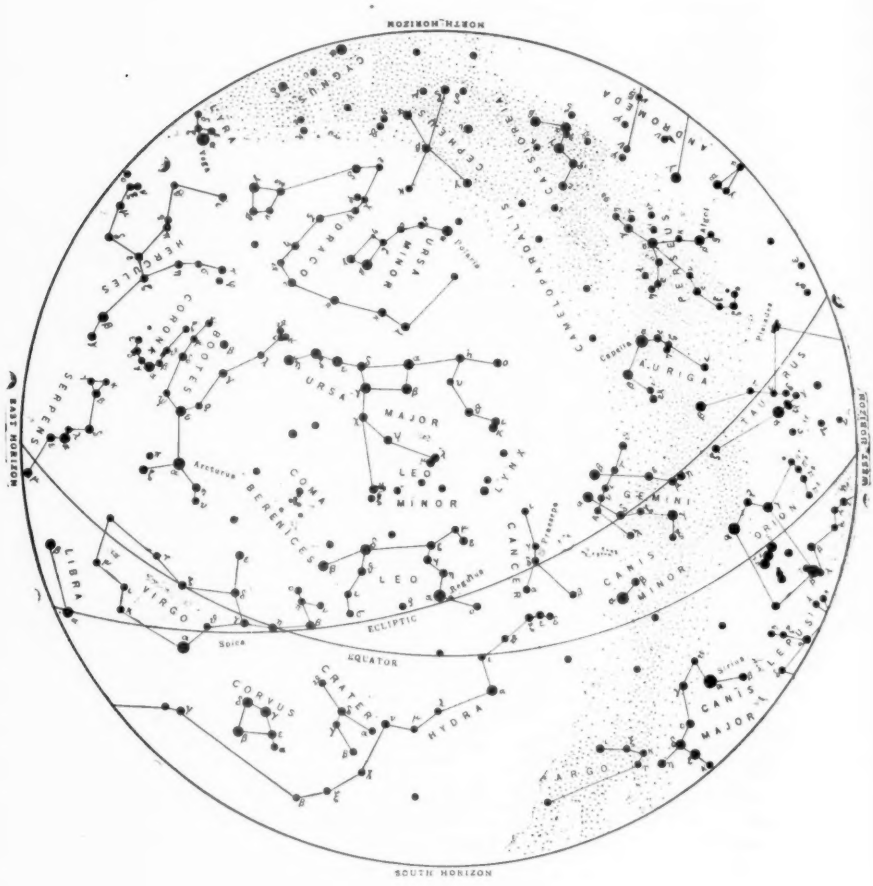
Saturn will also be at quadrature, 90° west from the Sun April 6, and will be seen under the same unfavorable conditions.

Uranus is about 25° west from Jupiter and may be observed in the morning hours.

Neptune can be observed in the early evening hours only. It is about 5° west and a little south of the star η Geminorum, but is invisible to the naked eye.

The Moon.

Phases.		Rises. (Central Standard Time at Northfield Local Time 13m less).		Sets.	
		h	m	h	m
April 3	Full Moon	6	44 P. M.	5	48 A. M.
11	Last Quarter	1	04 A. M.	10	43 "
18	New Moon	5	01 "	7	12 P. M.
25	First Quarter	11	29 "	1	43 A. M.



THE CONSTELLATIONS AT 9 P. M. APRIL, 1, 1901.

Occultations Visible at Washington.

Date. 1901.	Star's Name.	Magnitude.	IMMERSION. Washington M. T.	IMMERSION. Angle from N pt.	EMERSION. Washington M. T.	EMERSION. Angle from N pt.	Duration.
			h m	°	h m	°	h m
Apr. 8	B.A.C. 5758	6.6	13 03	99	14 29	276	1 26
22	χ^3 Orionis	5.1	8 53	103	9 51	279	0 57
25	A^1 Cancri	5.6	4 47	79	6 00	327	1 13
25	A^2 Cancri	5.8	7 39	111	8 59	302	1 20

COMET AND ASTEROID NOTES.

Comet 1898 VII, Definitive Orbit Elements.—In *Astr. Nach.* 3684-5, Mr. C. J. Merfield of Sydney, Australia, gives a very complete determination of the orbit elements of this comet. The observations extend almost continuously from June 11, 1898, to Feb. 15, 1899, and two observations at Lick Observatory in August, 1899, two in September and one in December, 1899, are also used in the investigation. The orbit turns out to be a hyperbola but the eccentricity differs but little from that of a parabola.

ELEMENTS.

Epoch of Osculation 1898 June 21.

$T = 1898$ Sept. 14.0442056 Gr. M. T.

$\omega = 233°\ 15'\ 18''.66$

$\Omega = 74\ 0\ 58\ .17$ 1900.0

$i = 69\ 56\ 0\ .37$

$\log q = 0.2308587$

$\log e = 0.0004487$

$e = 1.0010336$

Numbering of New Asteroids.—The following numbers have been assigned to the asteroids discovered at Heidelberg, in September and October, 1900, their orbits having been determined:

(457)	1900	*FJ*	discovered by	Wolf-Schwassman		Sept. 15
(458)		*FK*	"	"	"	Sept. 21
(459)		*FM*	"	" Wolf		Oct. 22
(460)		*FN*	"	" "		Oct. 22
(461)		*FP*	"	" "		Oct. 22
(462)		*FQ*	"	" "		Oct. 22
(463)		*FS*	"	" "		Oct. 31

The object 1900 *FL* has not been followed further. 1900 *FO* has been identified with (244) Sita and 1900 *FR* with (177) Irma. (462) 1900 *FQ* is identical with 1896 *DD*, for which only a circular orbit could be calculated and which was therefore not then numbered. (*Dr. J. Bauschinger in Astronomische Nachrichten* 3683).

Variability of Eros.—In *Astr. Nach.*, No. 3688, Dr. Egon von Oppolger announces the remarkable discovery of a variation in the light of Eros amounting to approximately one magnitude, the change taking place in a few hours. He states that he began a series of photometric measures of Eros on Dec. 20, 1900, using a Zöllner photometer on the Grubb refractor of 209^{mm} (8-inches) aperture. In order to avoid systematic errors as far as possible he made settings of the photometer circle in the four quadrants, with Eros above, below, to the right and to the left of the artificial star. He also measured the light of stars nearly equal to Eros in the same field of view on each night. Comparing twelve nights' measures he found variations in the brightness of Eros of a whole magnitude, but would not have regarded these as impossible errors of observation on so difficult an object as Eros, had they not been twice as great as the corresponding differences between the measures upon stars equally faint and difficult with Eros. He then began to watch the planet through several hours on the same night. On Feb. 8 the asteroid was near the star DM $+ 22°,658$ of magnitude 9.3 and very close to a star of the 11th magnitude. At first Eros was so nearly equal to the 11^m star that the observer was in doubt which was the planet. An hour later Eros was slightly brighter than the 9.3^m star, having increased 1.7 mag. according to

the photometric measures while the 11 mag. star remained as faint as at first. The asteroid remained bright for an hour, until clouds prevented further observation. The observer made visual comparisons of Eros with the neighboring stars, by the method of steps, at the same time with the photometer measures, and these estimates give the same variation to Eros as do the photometric measures.

On Feb. 8 Eros was noticeably fainter than DM $+22°,658$. On Feb. 11 a series of 4 hours observations again showed an increase of brightness amounting to 0.3 — 0.4 mag. On Feb. 12 no variation was noticed.

The same number of *Astr. Nach.* contains notes by H. Struve, of Königsberg, W. Valentine and E. Jost of Heidelberg, tending to confirm the observations of variability of Eros. The editor adds notice of a telegram received Feb. 22 from Prof. F. Deichmüller of Bonn stating that the period of light variation is about 2½ hours.

In *Astr. Nach.* No. 3692 Professor Otto Knopf, of Jena, gives a series of eye-estimates of the magnitude of Eros extending from Oct. 24, 1900, to Feb. 11, 1901, in which considerable variation is to be noticed, but trustworthy conclusions cannot be drawn until the magnitudes of the comparison stars are well determined.

The Eros Campaign.—*Bulletin* No. 7, issued Jan. 31, 1901, by President Loewy of the International Astro-photographic Conference assures us of the success of the Eros parallax campaign, so far as obtaining a great number of observations at a great number of stations widely separated on the Earth's surface is concerned. Reports are given showing the times of the separate observations at the following Observatories up to the close of 1900: Algiers, Abbadia, Besancon, Bordeaux, Cambridge (England), Catane, Christiana, Koenigsberg, Lisbon, Lyon, Marseilles, Nice, Oxford, Paris, Tachkent, Teramo, Toulouse, Washburn, Washington, Yerkes. A comparison of the reports shows a total of 306 coincidences in times of observation between the European Observatories and the three American Observatories whose reports are given:

NUMBER OF COINCIDENCES UP TO DEC. 31, 1900.

	Madison	Washington	Williams Bay	Total
Micrometric	40	49	106	195
Photographic	15	30	66	111

M. Loewy suggests the following order in which the vast amount of work necessary for the reduction and publication of all the observations connected with the problem should be carried out:

I. Construction of an Index to the observations made. This is inaugurated in the present circular with the aid of the reports which have come to hand.

II. Reduction of the meridian observations of the reference stars destined to determine the constants of the plates.

III. Calculation of the equatorial co-ordinates of the comparison stars from the special series of plates.

IV. Calculation of the equatorial co-ordinates of the stars shown on the plates devoted directly to the photography of Eros.

V. Publication of micrometric, photographic and heliometric observations of Eros.

VI. Publication of the researches recommended by the Conference of 1900, having for their object to determine more precisely the action of certain physical

causes, such as the influence of atmospheric dispersion on the measures, or that of the trails produced by the movement of the asteroid during the photographic observations.

M. Loewy agrees to publish in succinct form the communications which may be addressed to him on the above six points, in order that astronomers may have in hand as quickly as possible all the available data for the problem. The details of the observations and processes employed in reduction may be left to the Annals of the various Observatories.

A few experiments by the Messrs. Henry at Paris seem to show that the effect of the trailing of the planet's image during a few minutes' exposure will be insensible. The experiment was tried upon stars of different brightness, by varying the rate of the driving clock, producing an elongation of 3″ in 3 minutes, first by acceleration, then by retardation, then by the two processes in reverse order upon the same plate, the declination of the instrument being changed slightly between the successive steps. The differences of right ascension measured from the four images give practically insensible errors. The probable errors of single measures show a decided progression with the magnitude of the star, that for a 9 mag. star being ± 0″.06, for a 11 mag. star ± 0″.09 and for a 12 mag. star ± 0″.13.

Another interesting point discussed is the effect of an error of observation upon the solar parallax as determined from coincident observations of the planet. M. Loewy gives the formula

$$\epsilon_\pi = \frac{\Delta}{\sqrt{2}\,\sin\frac{A}{2}}\,\epsilon = f\epsilon;$$

in which ϵ_π represents the probable error of the solar parallax, ϵ the accidental error of a photographic or micrometric observation, supposed to be the same at both stations, A the arc of a great circle between the two places and Δ the apparent distance between the observed positions of Eros. The following table which gives the approximate values of A and f for the Observatories whose reports are at hand, shows that the error of the solar parallax from a single coincident pair of observations, American and European, will average about one half of the error of a single measure. Dr. Struve gives the probable error of a single micrometric measure at Kœnigsberg as ± 0″.077, hence the probable error of the solar parallax from a single pair of measures in Europe and America will be about ± 0″.04. This should be very greatly reduced when the great number of observations are combined.

	Madison.		Washington.		Williams Bay.	
	A	f	A	f	A	f
	° ′		° ′		° ′	
Algiers	67 25	0.40 — 0.57	61 06	0.44 — 0.59	67 07	0.40 — 0.55
Besancon	62 56	0.42 — 0.43	58 19	0.45 — 0.46	62 48	0.42 — 0.52
Bordeaux	60 33	0.44 — 0.45	55 09	0.48 — 0.48	60 20	0.44 — 0.55
Cambridge	57 04	0.45 — 0.74	52 57	0.50 — 0.80	56 57	0.45 — 0.61
Christiana	58 14	0.45 — 0.74	56 02	0.47 — 0.52	58 17	0.45 — 0.61
Kœnigsberg	65 33	0.41 — 0.58	63 01	0.42 — 0.45	65 35	0.41 — 0.44
Lyons	63 10	0.42 — 0.58	58 13	0.45 — 0.64	63 00	0.42 — 0.46
Marseilles	64 55	0.41 — 0.57	59 39	0.45 — 0.64	64 43	0.41 — 0.45
Nice	65 46	0.41 — 0.42	60 42	0.44 — 0.44	65 35	0.41 — 0.42
Oxford	56 34	0.47 — 0.47	52 18	0.50 — 0.51	56 27	0.47 — 0.49
Paris	60 02	0.44 — 0.53	55 27	0.47 — 0.73	59 53	0.44 — 0.61
Teramo	70 05	0.38 — 0.48	65 18	0.41 — 0.58	69 56	0.39 — 0.62
Tachkent	93 27	0.31 — 0.43	94 06	0.30 — 0.35	93 45	0.30 — 0.33
Toulouse	62 25	0.43 — 0.66	56 57	0.46 — 0.72	62 12	0.43 — 0.66

The *Bulletin* contains also a table of the logarithms a, b, c, d, etc. for the re

duction of the stars of reference; an ephemeris by Millosevich, based upon his lat est system of elements; a memoir by Comstock on the method to be employed in order to take account of refraction in the direction of diurnal movement; and a note by Hermann Struve on the precision of micrometric measures at the Observatory of Kœnigsberg. H. C. W.

GENERAL NOTES.

Board of Visitors for the Naval Observatory.—Under the provisions of the law of congress recently passed, the President has appointed the following named persons to constitute the first Board of Visitors:

St. Clair McKeway, of Brooklyn, N. Y.; Asaph Hall, Jr., of Ann Arbor, Mich.; William R. Harper, of Chicago; Edward C. Pickering, of Cambridge, Mass.; Charles A. Young, of Princeton, N. J.; Ormond Stone, of Charlottesville, Va.

More Trouble at the Naval Observatory.—From the Washington papers of last month, we learn of more trouble at the United States Naval Observatory. This time particular interest seems to arise from the fact that Capt. C. H. Davis, the Superintendent, has preferred charges against Stimson J. Brown, director of the Nautical Almanac and astronomical director of the Observatory, who is an officer of the Navy with the rank of Captain. The Secretary of the Navy has placed the formal charges before director Brown, as a preliminary step for a court of inquiry whose duty will be to determine whether or not the charges are important enough to require a court-martial for full investigation.

It is very difficult at this time to learn exactly on what grounds Capt. Davis makes charges against Capt. Brown, because all persons having knowledge of facts in the case have surrounded them with the greatest secrecy. The reports which the daily papers are circulating very freely, as to the ground of charges may be true, partly true, or not true at all. So what is said in particular about specific charges will not be repeated. It may be enough to say that the differences of opinion as to the best way of managing the Observatory, held by these two officers of the same rank in the Navy is probably the cause of the trouble. Such differences of opinion might naturally reach an acute stage during the last few weeks, because some legislation was before Congress which very directly concerned the official duties of these two gentlemen. In the nature of the case they would be likely to act vigorously and explicitly to the limit of personal and official privilege, for both men say what they think, without stopping to dress their official communications in the suave etiquette of official reserve, so usual and so necessary to the dignity of rank in science and governmental position. The present director of the Observatory, as we are informed, has written a letter setting forth his views in regard to the best way of managing the Observatory. He says that the Observatory has been subjected to a most continuous criticism, from the general body of astronomers outside of that institution. While some of the criticism has been actuated, undoubtedly, by selfish motives, yet most of it represents a dissatisfaction of astronomers outside, because the Observatory has failed to reach the high standard of accuracy, and to secure the continuity of work which should be expected of a government Observatory with the generous support which it has received.

The almost unanimous opinion, he says, seems to be that the cause of the failure of the Observatory to meet the expectations of the astronomical people of

the country is due to a lack of competent professional direction, and that it will not be possible for it to reach the standard justly expected, except under the administration of an experienced astronomer.

These are the views that have been maintained in this publication and others preceding it, for nearly a score of years past. We will remember the discussions that agitated astronomical circles when the now famous Admiral Sampson was Superintendent of the Observatory.

Naval Observatory Legislation.—The appropriation bill which passed last Congress, provided $149,571, for the purchase of land lying within the Naval Observatory circle, and $10,000 for the improvment of grounds around the Observatory. The following are the provisions of the law relating to tne administration of the Observatory:

"There shall be appointed by the President, by and with the advice and consent of the Senate, from persons not officers of the United States a board of six visitors to the Naval Observatory, four to be astronomers of high professional standing and two to be eminent citizens of the United Seates. Appointments to this board shall be made for the periods of three years, but provision shall be made by initial appointments for shorter terms, so that two members shall retire in each year. Members of this board shall serve without compensation, but the Secretary of the Navy shall pay the actual expenses necessarily incurred by members of the board in the discharge of such duties as are assingned to them by the Secretary of the Navy or are otherwise imposed upon them. The board of visitors shall make an annual visitation to the Observatory at a date to be determined by the Secretary of the Navy, and may make such other visitations not exceeding two in number annually by the full board or by a duly appointed committee as may be deemed needful or expedient by a majority of the board. The board of visitors shall report to the Secretary of the Navy at least once in each year the result of its examinations of the Naval Observatory as respects the condition of buildings, instruments and apparatus. and the efficiency with which its scientific work is prosecuted, and shall also report as respects the expenditures in the administration of the Observatory. The board of visitors shall prepare and submit to the Secretary of the Navy regulations prescribing the scope of the astronomical and other researches of the Observatory and the duties of its staff with reference thereto. When an appointment or detail is to be made to the office of astronomical director, director of the Nautical Almanac, astronomer or assistant astronomer, the board of visitors may recommend to the Secretaey of the Navy a suitable person to fill such office, but such recommendation shall be determined only by a majority vote of the members present at a regularly called meeting of the board held in the city of Washington. The superintendent of the Naval Observatory shall be until further legislation by Congress, a line officer of the navy of a rank not below that of captain."

Observations of Nova Persei at the Seagrave Observatory.—Anderson's Nova Persei was observed here for the first time last Saturday evening. Although thick clouds covered the sky, the star was visible after all others were obscured, Capella excepted. The star was very brilliant on Sunday morning and was estimated at 3/10 of a magnitude fainter than Capella, and was an easy object in a two-inch telescope. At $6^h\ 30^m$ Sunday evening (Feb. 24th) the star was estimated to be 4/10 of a magnitude fainter than Capella and gradually declining. At $7^h\ 50^m$ 4/10 of a magnitude fainter than Capella and 6/10 of a magnitude brighter than Pollux (β Geminorum), and decidedly orange in color.

During the evening the star was examined with a small Browning direct vision three prism spectroscope. There were no bright lines, but the spectrum consisted of numerous broad dark bands situated principally in the blue and the extreme red end. On Monday night at $6^h\ 50^m$ the star was estimated at 2/10 fainter than Betelgeuse, add 3/10 brighter than Pollux, and redder in color. The spectrum appeared the same, but much fainter. Last night at $9^h\ 30^m$ the star was estimated at 2/10 fainter than Pollux and 4/10 brighter than Castor, and reddish orange in color. If my estimates are correct the star has declined about 1 1/10 of a magnitude within the past fifty hours. F. E. SEAGRAVE.

PROVIDENCE, R. I., Feb. 27, 1901.

The following observations from Mr. Seagrave were received later:

1901	Feb.	23	23	Var. 2 grades fainter than Capella.
		24	7	Var. 3 " " " "
		24	8	Capella 3½ V, V 5 Pollux.
		25	7	Betelgeuse 2 V, V 2 Pollux.
		25	10	" 1½ V, V 2 Pollux.
		26	7	Pollux 1½ V, V 2½ Castor.
		26	9	" " " " " "
		26	10	Pollux 1½ V, V 3 Castor.
		26	11	" " " " " "
		27	6	Castor 1½ V, V 1 α Persei, twilight.
		27	8	α Persei 1 V, V 1 α Arietis.
	March	6	7	Var. 1 grade brighter than γ Persei.
		6	9	γ Persei ½ V, V ½ δ Persei.
		6	10	" " " " " "
		7	7	ζ 1 V, V 1 γ Persei.
		7	8	ζ Persei 1 V, V ½ γ Persei.
		7	9	ζ Persei 1 V, V 1 γ Persei.
		11	9	Var. ½ grade brighter than ρ Persei, through clouds.
		12	7	δ Persei 1 V, V 1 ρ Persei.
		12	8	δ Persei 1 V, V 1½ ρ Persei.
		12	10	" " " " " "

Observations of Nova Persei at Yerkes Observatory.—Observations of the Nova at the Yerkes Observatory began Feb. 24, and have been continued every clear night since. They consist of:

(1). Photographs of the spectrum, taken with the 40-inch refractor and extending, on different plates, from λ 6600 in the red, to λ 3700 in the ultra-violet. One or two complete sets are taken each night, showing the progressive changes which are characteristic of new stars near their maxima. The resemblance to the spectrum of Nova Aurigae is marked. The hydrogen lines Hα, Hβ, Hγ, Hδ, Hϵ, Hζ, Hη, Hθ, Hι are present, bright, broad, and in some cases traversed by two or more dark lines. As in the case of other Novæ, they are accompanied on their more refrangible edge by dark lines. Hα and Hβ are remarkably brilliant. The sodium line D is bright and very broad, with the narrow dark D lines superposed upon it. These latter lines indicate a moderate velocity of recession for the Nova. The magnesium line *b* is conspicuous, and a broad, bright line covers the position of the chief nebular line. D_3 (helium) is present as a dark line, H and K (calcium) are bright and exhibit interesting reversal phenomena.

(2). Chart plates of the Nova and surrounding region for parallax, also taken with the 40-inch. By covering the image of the Nova with a small disk, giving a long exposure to the surrounding faint stars, then giving short exposures to the Nova at intervals, it is possible to get sharp images of all, in spite of the great difference in magnitude. The great scale of plates taken with the 40-inch,

together with the clean, cut images which Mr. Ritchey obtains with the color screen and guiding device, make this a most promising method of determining the parallax, or want of parallax, according to the analogy of the previous new stars.

(3). Photometric measures of the light of the Nova, made with a wedge photometer, designed by Professor E. C. Pickering for determinations of standards of faint stellar magnitude. So far this photometer has been used with objectives of one and two inches aperture, as required by the brightness of the star, but it is also adapted for use with the larger telescopes. A preliminary reduction gives the following magnitudes:

1901	Feb. 25,	1.0	1901	Mar. 3,	2.7
	26,	1.1		4,	2.8
	27,	2.0		5,	2.7
	28,	1.9		6,	3.1

J. A. PARKHURST.

Notation of New Variables.—I trust that I will be pardoned for publishing the following personal communication from Dr. Kreutz, the editor of the *Nachrichten*, in regard to the notation of new variables.

"In the last number of POPULAR ASTRONOMY, page 105, you note that in my list of new variables in *A. N.* 3675 (not 3765) Barnard's new variable in the cluster Messier 13 is wanting. I have purposely left it out, because, first: The variables in clusters form a particular class, which had better be kept separate from the other variables, and second: A provisional notation is not needed since the name of the cluster will suffice."

The above explanation is welcomed as an authoritative statement on a hitherto unsettled question. J. A. PARKHURST.

Nomenclature of Variable Stars.—No one recognizes more fully or with more regret than the undersigned the inconvenience and danger of confusion attending the prolonged delay in the assignment of the nomenclature to the rapidly increasing list of new unnamed variables, and in the publication of a new catalogue; or the personal responsibility for the blame of allowing these matters to fall into desuetude. It has been his hope to continue the work by the preparation of a Fourth Catalogue long ere this, but the pressure of other tasks and avocations have been such as to prevent its fulfillment up to the present time, and would postpone it now to an extent that cannot for an instant be considered or tolerated. He must therefore resign the task, reluctantly in one sense, but cheerfully in another, into the hands of some one who is willing and competent to take it up. It is a work demanding such punctiliousness and complete and instant conversance with detail that no one who is distracted by other subjects to a large extent can perform it properly; far less can it be done at second hand, or by superintendence, or by committee, except in a slovenly manner, worse than its not being done at all.

Dr. Hartwig has shown such unremitting interest in the subject, has the requisite details so fully in hand and mind, and is so eminently the one to whom we can look for the continuence of this work, and its maintenance at the high standard set by Schoenfeld, that it is to be hoped he will feel disposed to take it upon his hands. If so, the *Journal* will unhesitatingly adopt any notation that he may assign, to variables at present unnamed or hereafter discovered, according to established rubrics; accepting his interpretation of the same as authoratative without demur or criticism; and in fact, cheerfully extend to him the courtesy in

such matters that has so long been extended by him and others to the undersigned, who is deeply sensible of and grateful for it.—*The Astronomical Journal.*

S. C. CHANDLER.

Observations of Nova Persei at Ladd Observatory.—Observations of Nova Persei at the Ladd Observatory give the following results to date:

Magnitudes have been estimated by careful eye comparisons with neighboring stars. On the scale of the Harvard photometry they are:

Feb. 24	0.3	Feb. 28	1.8
25	1.0	Mar. 1	2.1
26	1.2	6	3.2
27	1.9	7	3.0

The color was somewhat orange tinted on Feb. 24th when the star was nearly as bright as Capella, and has become of more pronounced red, as the star has faded. The increase of brightness recorded an Feb. 28th and March 7th is believed to be real.

The spectrum was first obtained on Feb. 27th, with a single 60° flint prism on a slit spectroscope attached to the twelve-inch refractor. It showed four bright bands in the blue, two in the green, and one in the red, with a faint band in the yellow. On the 28th, the continuous background was more marked in the red and the red and yellow lines more prominent. The positives of the bands have been measured. They correspond with *C*, *D*, b_1, *F* and *G* with two other bands between *D* and b_1 and also between b_1 and *F*. The spectrum has been twice photographed, March 6 and 7, showing more bright bands between *G* and *H* which were but dimly seen by the eye. Observations have been made by Messrs. Slocum, Edwards and myself. WINSLOW UPTON.

PROVIDENCE, R. I.,
March 8, 1901.

Observations of Nova Persei at Poughkeepsie.—The new star in Perseus was first seen at Vassar College about 11 P. M., Feb. 21, by a student in the astronomical department. It was then as bright if not brighter than Capella. It has lost brightness since that time, but its decline has not been steady. On the 25th about 10 P. M. it was closely of the magnitude of Pollux. On the 26th it was about half way between Castor and Pollux, and on the 27th about equal to α Persei, if not a trifle fainter. But on the 28th it was a little brighter than α Persei. One of my students who has been noting the color of the Nova, states that it looked decidedly redder to her on Feb. 23, when she first saw it, than it did on the 27th.

On Feb. 25th and following clear evenings the spectrum of the Nova has been observed with a McClean star spectroscope, attached to the twelve-inch equatorial. The spectrum is continuous, crossed by bright lines, and dark bands. Clearly defined narrow dark lines we could not detect. Hα is beautifully clear and sharp, with a dark space on its more refrangible edge, suggesting the light and dark companions in the spectrum of Nova Aurigæ. Three faint red lines were noted petween Hα and a clearly marked yellow line, that may be sodium or helium. Miss Davis, one of our observers, noted a darker space on the more refrangible edge of this yellow line, but it was not well defined. Between the yellow line and a sharply defined green line, that may be the magnesium group, are three dim green lines. Whether these are lines or the continuous spectrum between bands we cannot decide. Following (on the more refrangible side again)

the sharp green line is a dark band, but not well defined. It shades into another green line that is merely not so distinctly marked as the one above mentioned. Then comes a much darkened region, through which runs, just before the Hβ is reached, a narrow bright line. Hβ is beautifully clear. These four in the green and peacock blue resemble the grouping of the four leading lines in the spectrum of Nova Aurigæ between λ 520 and λ 480 (p. 284 Frost's translation of Scheiner). On the violet edge of Hβ follows a dark region, but it does not look like a repetition in dark of Hβ, as it has much greater width. The continuous spectrum seems to gleam out for a space before Hγ is seen, plainly bright. Beyond Hγ is very difficult seeing, but what we take to be Hδ has been noted. Either our eyes have become keener or the violet-end of the spectrum has grown brighter since Feb. 25.

We await with impatient interest the reports from larger observatories and the results of photographic investigation. MARY E. WHITNEY.

Observations of Nova Persei at Pomona College, Claremont, California.—An elective class in astronomy at Pomona College, Claremont, Cal., has been observing variables in Perseus and two of its members, Mr. J. C. Gould and Mr. L. E. H. Cone, are entitled to credit for independent discovery of the new star in Perseus. Mr. Gould saw it Saturday, Feb. 23, about $7^h\ 30^m$ and recorded its magnitude as nearly as bright as Aldebaran and almost as red. Mr. Cone saw it first Sunday, Feb. 24, about $9^h\ 30^m$ at Santa Ana and called it nearly as bright as Capella. The class is following its decline with a number of observations each night. Doubtless the star would have been seen earlier but for the holidays coming at the time of Washington's birthday, as they have been working in that region. F. P. BRACKETT.

The Crocker Eclipse Expedition to Sumatra.—The total solar eclipse of May 17, 1901, is one of the most important astronomical events of recent times, on account of its long duration. The path of totality crosses the islands of Mauritius, Sumatra, Borneo, Celebes, Ceram, New Guinea, etc. Its duration reaches a maximum of six and one-half minutes on the west coast of Sumatra. This is, I believe, the longest duration for any *observable* eclipse in the last half-century, since serious eclipse-work began; though eclipses of slightly longer duration have occurred on the ocean. It is a fortunate circumstance that on the west coast of Sumatra the eclipse occurs near noon, (at twenty-two minutes after local mean noon) with the Sun only 21° from the zenith. While the weather conditions along the line are not of the best, yet they appear to be as promising in western Sumatra as in any of the islands farther east. This is likewise the region most accessible for observing parties.

The Lick Observatory has had it in mind to prepare extensively for the suitable observation of this important eclipse. However, the reduced size of our observing staff, and the pressure of work on the Eros campaign, made it impossible to plan for the expedition, until the middle of January.

It is a pleasure to announce that the Lick Observatory is again indebted to the generosity of William H. Crocker, Esq., who has offered, by virtue of his interest in the work, to defray all the expenses of an expedition to Sumatra.

The expedition plans to leave San Francisco on February 19th, traveling via Yokohama, Hong Kong and Singapore. It should reach Padang, Sumatra, about April 10th. Assistant astronomer C. D. Perrine will be in charge, accompanied by one assistant from here. He will plan to secure the services of ten or twelve local assistants, during the week of the eclipse, from among the foreigners in Padang.

The long duration makes this the occasion for investigations on the corona, rather than on the edge of the Sun. It also affords unusual advantages for a search for unknown objects in the Sun's vicinity,—such as the planet, or planets, Vulcan. Accordingly, the work will be largely limited to these lines. I regret that we shall not be able to spare from the Observatory a spectroscopic observer; but I shall send one or two simple spectrographs along with the party, suitable for recording the coronal spectrum, hoping that the pressure of other work will not prevent their use. W. W. CAMPBELL.

Eclipse Party from Washington for Sumatra sailed from San Francisco Feb. 16 on board the U. S. Transport Sheridan for Manila. The party will be conveyed from Manila on a war vessel to Sumatra, the place chosen for the observation of the total solar eclipse of May 17, 1901. The party consists of E. E. Barnard, Yerkes Observatory; F. B. Little, W. S. Exchielberger, A. N. Skinner, Paul A. Draper, L. E. Jewell and C. H. Peters, U. S. N. Observatory; S. A. Mitchell, Columbia; H. D. Curtis, Walter Dunweddie and W. J. Humphreys, of Virginia; C. G. Abbott, Smithsonian Institute; and W. J. Hussey, Lick Observatory.

The Spectrum of ζ Puppis.—The presence of a second series of hydrogen lines, in addition to the ordinary series, in the spectrum of ζ Puppis, was announced in Circulars Nos. 12, 16, and 18. Accurate wave-lengths could not then be determined for the less refrangible lines. Since then, measures have been made of six photographs of spectra of ζ Puppis, and two of spectra of δ Orionis. The measurements have been made by Miss F. Cushman, and the conversion into wave-lengths, by Mr. Edward S. King, with the assistance of Miss Cannon. This work will be published in full in a later volume of the Annals. Following the notation proposed by Vogel for the ordinary series of hydrogen lines, the new series may be designated, Hα', Hβ', Hγ', etc. The great difficulty in determining the wave-length of Hβ', which is approximately 5414, is that no known lines of greater wave-length have been found in the spectrum of ζ Puppis. Accordingly, extrapolation, which is always uncertain, must be employed. The star, δ Orionis, besides the line Hβ', contains also the known line D_3, wave-length 5876, which thus permits the wave-length of Hβ' to be determined by interpolation. These lines also occur in ϵ Orionis, and probably in other stars of the so-called Orion type. It is greatly to be desired that the spectra of these stars should be photographed with a slit spectroscope attached to a large telescope, as the wave-lengths of these lines could then be determined with far greater accuracy by the help of a comparison spectrum. A comparison of the mean of the wave-lengths given in Circular No. 16, with those recently determined, and with two computed values, is given in the following table. The first of these is given in the following table. The first of these is given in Circular No. 16, and is a slight modification of Balmer's formula. It is $3646.1 \frac{n^2}{n^2-16}$, in which n is an even number for the ordinary series of hydrogen lines, and an odd number for the additional series. The second formula is $\frac{1}{\lambda} = A + B\frac{1}{m^2} + C\frac{1}{m^4}$. This form was proposed by Kayser, immediately after the announcement of the discovery of this series of lines. If we accept this formula, it would appear to be the true law connecting their wave-lengths, and would render them comparable with those of other elements. The designation of the lines is given in the first column of the following table, the mean of the observed wave-lengths given in Circular No. 16,

is contained in the second column, and the wave-lengths derived by Mr. King in the third column. The next four columns give the value of n, taken from the sixth column of the table in Circular No. 16 and computed wave-lengths taken from the seventh column of the same table, and the residuals found by subtracting the computed values from the observed values given in the second and third columns. A similar comparison with the formula $\frac{1}{\lambda}=27461-121790\,\frac{1}{m^2}-352010\,\frac{1}{m^4}$, is contained in the last four columns of the table.

Des.	Cir. 16.	Obs.	n.	Comp.	O—C.	O—C.	m.	Comp.	O—C.	O—C.
Hα'	.....	.....	5	10128.1	...	...	3	10435.2	...	...
Hβ'	.....	5413.6	7	5413.9	...	− 0.3	4	5413.0	...	+ 0.6
Hγ'	.....	4542.4	9	4543.6	...	− 1.2	5	4540.1	...	+ 2.3
Hδ'	4200.6	4200.7	11	4201.7	− 1.1	− 1.0	6	4200.6	0.0	+ 0.1
Hϵ'	4026.3	4026.0	13	4027.4	− 1.1	− 1.4	7	4027.5	− 1.2	− 1.5
Hζ'	3924.8	3924.0	15	3925.2	− 0.4	− 1.2	8	3925.8	− 1.0	− 1.8
Hθ'	3858.6	3860.8	17	3859.8	− 1.2	+ 1.0	9	3860.9	− 2.0	+ 0.2
Hι'	3816.0	3815.7	19	3815.2	+ 0.8	+ 0.5	10	3815.4	+ 0.6	+ 0.3
	3783.4	.....	21	3783.4	0.0	...	11	3782.1	+ 1.3	...
	.....	.....	∞	3646.1	...	...	∞	3641.5	...	...

It will be noticed that the two computed values do not differ very greatly for any of the observed lines. The difference is greatest for Hγ', and here the observed value is nearly midway between the two computed values. On the whole, the observed values agree more nearly with first formula, than with the second. This is remarkable, if it does not represent the true law, since this formula contains no arbitrary constants. There is only one constant, and that is determined with great accuracy from the ordinary series of hydrogen lines. The second formula contains three arbitrary constants which are selected so as to represent the observed values as nearly as possible. A least square determination was not considered necessary, since the outstanding differences from observation were evidently systematic, and not accidental. The wave-length when m or n is infinite, could be accurately measured, but unfortunately these lines, like those of the ordinary series, do not appear to be present in the stars. The wave-length of the line Hα' differs greatly according to the two formulas, but no means as yet exist for determining radiations of such great wave-length in a star.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY, Circular No. 55.
Cambridge, U. S., Feb. 11, 1901.

Evanescent Star Photographs.—Some little time ago we described the unfortunate condition into which some negatives of the great star-atlas series had fallen. Many of the smaller magnitude stars had absolutely disappeared from the plates, and it was feared that others would follow. Sir William Crookes, having heard of the catastrophe, kindly offered to endeavor to find a method for bringing back the images, and he has been quite successful. The plates he treated had had the star images they contained counted, and after Sir William's treatment the missing numbers all had reappeared as shown by a re-counting. The method adopted was virtually that of re-development and gold toning of the reproduced image. The first treatment consisted in a three hours' soaking in distilled water. The plate was then placed in the dark in an ordinary

pyro-soda developer for ten to fifteen minutes, and afterwards well washed. After this a half-hour's immersion in a 15 per cent. hypo-solution was given, and the plate washed in running water for three hours. The plate was brought to a good color by an acid, alum, and sulphate of iron bath, and washed for six hours. The final process consisted in toning the plate by a sulphocyanide gold bath of ordinary strength, i. e., about a grain of gold to eight ounces of solution and six or seven grains of sulphocyanide to each grain of gold. The net result of the whole question was, as stated, a complete success, and Sir Wm. Crookes in his letter made the suggestion that it would be advantageous to employ the clearing solution and sulphocyanide and gold toning to all negatives taken under ordinary conditions.—*The British Journal of Photograyhy.*

Dr. Lewis Swift has disposed of his astronomical equipment to the Pasadena and Mount Lowe Railway. The instruments are to remain on Echo Mountain, and Professor E. L. Larkin is now director of the Observatory.

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